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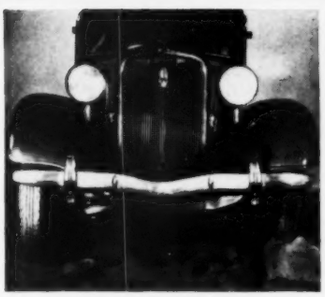

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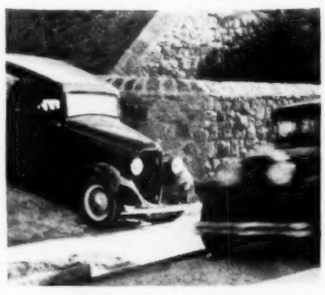

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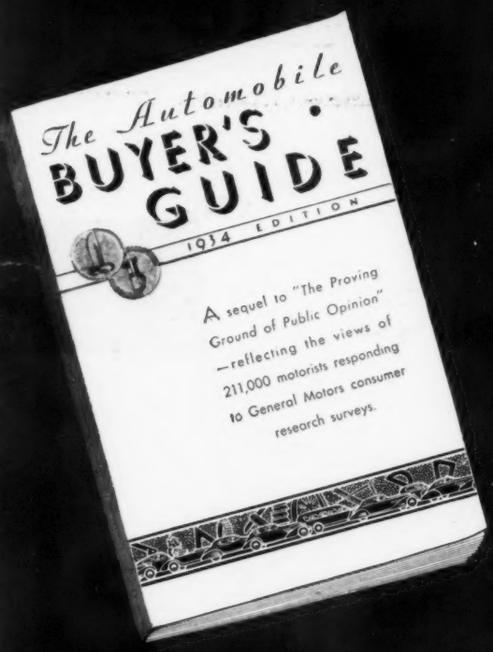
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POPULAR SCIENCE

FOUNDED MONTHLY 1872

VOLUME 124 · NUMBER 4
15 Cents a Copy · $1.50 a Year
Published Monthly by
Popular Science Publishing Co., Inc.,
381 Fourth Ave., New York

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April, 1934, Vol. 124, No. 4. **Popular Science Monthly** is published monthly at 381 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. A. L. Cole, President and Treasurer; R. C. Wilson, Vice President; John Nichols, Vice President; F. W. Briggs, Sec'y. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Copyright, 1934, by the Popular Science Publishing Co., Inc. Single copy, 15 cents (20 cents in Canada). Yearly subscriptions to United States and its possessions, $1.50; foreign countries, including Canada, $2. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address. The contents of this magazine must not be reprinted without permission. The editors are not responsible for unsolicited contributions, and cannot guarantee the return of such material or insure against its loss. Contributions not accompanied by sufficient postage will not be returned. In presenting numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized.

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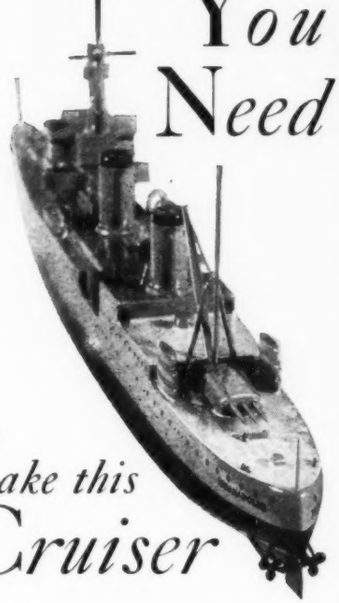
Everything You Need



to make this **Cruiser**

WITH a pocketknife, some single-edged razor blades, and a few simple tools that are to be found in every household, anyone can now build a beautiful 12 in. long model of the powerful new U. S. battle cruiser *Indianapolis* Our complete kit of materials makes it easy—so easy, in fact, that the man or boy who has never before constructed a model is certain to be entirely successful.

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Some men knew about it before. Men who realize the necessity of keeping astride of new developments that may affect their own business and who also know that the best way to do this is to watch the pages of Popular Science Monthly. SEVEN YEARS AGO they read in this magazine the first complete story of the "seadrome"—under the title of "Will We Hop the Ocean on Floating Islands?"

Not that these floating islands are now an accomplished fact. Their practical value is still to be demonstrated. But the important point is that the "seadrome" is a new invention, a new departure in mechanical science. It will call for new construction methods, the possible development of new materials.

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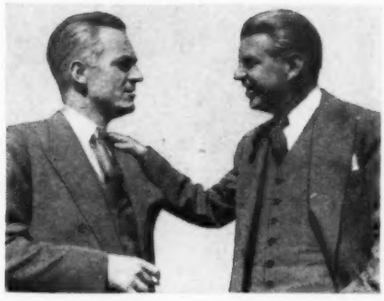

"I'LL DRAW an income of $200 a month *for the rest of my life*, as soon as I'm 55," said a certain man who was discussing his plans for the future.

"How can you do it on *your* salary?" asked his friend.

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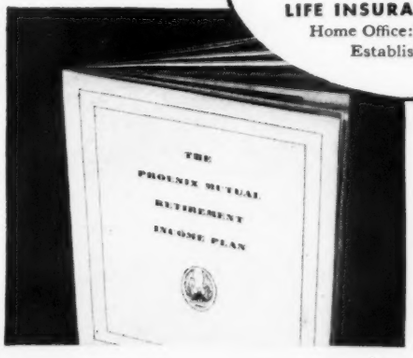

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RIGHT

Illustration at left shows the right way to light your shop so no confusing shadows will fall on the work. Below, the light not only throws shadows but also shines in the worker's eyes

WRONG

Lighting Your Home Workshop

By R. M. BOLEN

Secretary, Popular Science Institute

ADEQUATE lighting is the first requisite of a well-equipped home workshop. Almost more important than the tools and benches is the illumination of the work. Poorly lighted quarters are no better fitted for woodworking or model making than they are for reading.

A bare bulb dangling from the ceiling may give a bright light, but its harsh, glaring globe is a menace to the eyes and wasteful as well. To be safe, pleasant, and economical, a shop should be lighted evenly, with corners and shelves as well as benches clearly visible. Main lights fitted with reflectors or globes should be supplemented with portable local lights that can be placed where they will do the most good.

Because no two shops are exactly alike, it is impossible to give any hard and fast rules that will apply in all cases. There are, however, general suggestions that will help you to light your shop efficiently and according to the best practice.

The first step in securing just the right amount of illumination is to check the existing light sources. In this portion of the work, you can enlist the free services of your lighting company. Most power and light companies now maintain a crew of lighting engineers, arming them with vest-pocket foot candle meters that give a direct reading of the light available at any point. They will be glad to send one of these representatives to your home to test the illumination. When the measurements have been made, suggestions will be given regarding the illumination required.

Coupled with the intensity of the light are the factors of direction and quality. Lamps used without reflectors, for instance, create a disturbing glare, spreading a great portion of the light over the ceiling instead of directing it down to the working plane where it is most needed.

A single, well-shielded light source in the center of your *(Continued on page 9)*

LIGHTING YOUR HOME WORKSHOP

(Continued from page 8)

workshop ceiling may give ample illumination for movement around the shop, but when machines located near the walls must be used, it will throw dangerous shadows on the work. For this reason, local lighting at each individual machine forms an important feature in a well-lighted shop. Wherever possible, shadows and glare must be eliminated.

The size as well as the shape of your shop has a direct bearing on the best method of illumination. Also, the type of work that forms your particular hobby should be a deciding factor in your choice of lights. Ship-model rigging, jig-sawing, routing, staining, and finishing—to mention a few types of work—require the best possible illumination if eye strain and fatigue are to be avoided.

Convenience of control also is an important consideration when planning the lighting equipment in a shop. Switches and plug-in receptacles for portable tools should be placed conveniently. If possible, lights and power tools should be rigged on separate circuits to insure light even if a short-circuited cord or motor is plugged into a receptacle and blows a fuse. The fuse cabinet also should be conveniently located on the wall where it will be readily accessible in emergencies.

Other factors entering into the home-workshop lighting problem are the height and finish of the ceiling, the cleanliness and color of the walls.

With all of these factors in mind, the Popular Science Institute has prepared a booklet entitled, "Lighting Your Home Workshop." It deals more specifically with the problem of illumination than an article of this length possibly could. The booklet discusses in a detailed step-by-step manner ideal workshop layouts from a good lighting viewpoint. It will help you to place switches, locate outlets, choose the right type of lamp and reflector, and install local lighting that will eliminate shadows.

To assist you even further with your particular problems, a prepared form that will enable you to tell us about the exact conditions existing in your shop is included with every booklet. By filling it out, noting on it any questions you have, and returning it to us, you will make it possible for us to endeavor to supply you with the necessary information.

To obtain this new booklet use coupon below.

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381 Fourth Ave.,
New York, N. Y.

I want your new booklet on lighting the home workshop. Enclosed is ten cents in stamps (or coin). Send it to

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.....

Is YOUR light WORKING WITH YOU ..or against you?

NO MAN can work properly if he can't see properly. That is why workshop lighting *must* be good. If your lighting is poor and working against you, either your work suffers or you strain your eyes. Play safe. Find out if your lighting is good—or bad. *Test* it. You can make the test yourself—this simple way.

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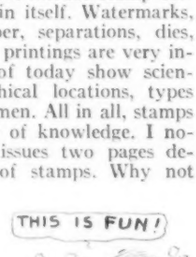
Our Readers Say

Here's a Red-Hot Argument About Heat that Isn't Heat

THIS is an answer to M. K., Los Angeles, Calif., who appealed to the Einsteins who read POPULAR SCIENCE MONTHLY. We think that if he had consulted some good encyclopedia he would have had no trouble with his problems. The question seems to concern the nature of heat and of course everybody knows that heat is not heat unless it has some material thing to effect. In the first case, if M. K. could actually go to the sun, he would get pretty hot because his body would conduct heat. Out in space, where there is no matter, there is no heat, because there is nothing to conduct heat. In the second case, the surface of the moon is hot because the moon itself acts as a conductor. On the earth the same thing happens as on the moon, with this difference, that the earth's atmosphere reflects the heat that rises from the ground. Since the moon has no atmosphere, its heat escapes rapidly causing violent changes in temperature. Of course, the air itself is a conductor, but the thinner it gets the less heat it will absorb. Therefore, the further you go from the earth, the colder it gets. —F. E. S. and C. J. C., Littleton, N. H.

If the Whole 5,000,000 Agree, Your Suggestion Is Good

I WISH to suggest that a stamp page be organized in your magazine, an outline telling of the new stamps being issued by various countries. You may reject the suggestion because you feel it has nothing to do with your magazine. I think that new inventions and ideas go with new stamps. In your magazine you have information on boatbuilding, microscopical work, and railroading hobbies. Why not include stamp collecting? It is a science in itself. Watermarks, different kinds of paper, separations, dies, grills, different types of printings are very interesting. The stamps of today show scientific progress, geographical locations, types of people, and famous men. All in all, stamps contain a great variety of knowledge. I noticed in one of your issues two pages devoted to the science of stamps. Why not keep it up as a regular department in each issue? Do you know that it is estimated that over 5,000,000 people collect stamps? This is more than the population of the combined states of Indiana and Maryland. Also you should remember that stamp collecting is prescribed by physicians as a means of giving the tired business man rest.—A. P. Jr., Bloomfield, N. J.



Anchored Airports At Sea Safe Only During a Storm!

I READ with great interest in a recent issue of your magazine, about the floating airports and how they could withstand storms and high seas and be comfortable in any weather at sea. There is no doubt about the feasibility of anchoring the structure and making it safe and comfortable in time of storm. How are they going to keep the structure from riding the moorings and stepping into the bight of the anchor cable in calm or light and contrary winds? When that happens, how will it be cleared? When it drifts athwart the moorings, how will it free itself or how can it be towed clear? There are more light, shifting winds at sea than there are storm winds. From looking over the sketch of the structure and the anchor gear, it seems that the only time that the seadrome will be safe is during a heavy storm. And at such times, of course, while the port would be safe, it would be impossible for planes to fly and the refuge would be useless.—J. McC., Leonia, N. J.

Speed of Gravity Waves Is Worrying This Reader

HERE is a problem that I hope some one of your readers can explain for me: We are told that the waves of gravity are the shortest of all waves, but what about their speed? For instance, let's take a common plank, four inches wide and ten feet long, weighing fifteen pounds. When the plank is lying in a horizontal position, the pull of gravity acts through three and a half square feet. Now by flipping the board, as quickly as we can imagine, to a vertical position, gravity is pulling the same amount through only two or three square inches. Does this mean that waves of gravity are so fast and so short, that they can concentrate instantly as to radial area and also be practically constant? In line with the same idea, is there an appreciable difference in weight, in a rapidly turning wheel, between the down-turning side and the up-turning side due to the difference betwen plus and minus gravity acceleration?—R. N. L., Seattle, Wash.

Building His Own Library of Priceless Information

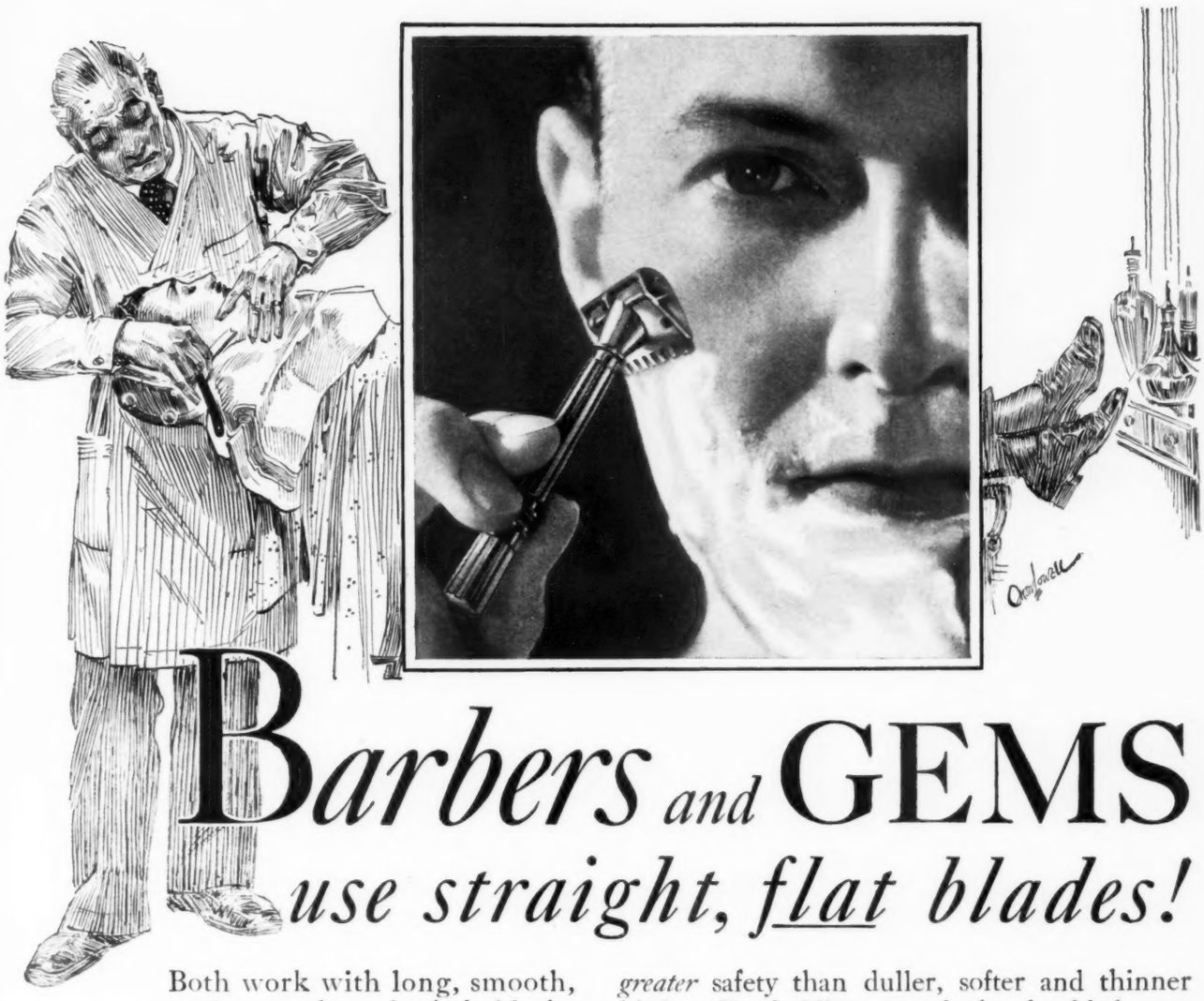
I HAVE every issue of your splendid magazine for the past five years indexed and filed. I have found the library a vast and very valuable store of knowledge for which I have yet to find a substitute. Not only is it valuable from month to month for its individual home workshop projects but also for the clear and concise way in which it shows the rapid strides of science over a period of time. I cannot help but wonder as to the great value of this library ten or twelve years from now, especially if it is added to month by month as it most certainly is going to be.—H. L. McD., Vancouver, Can.

Cry from Oklahoma for More and More on Radio

DO YOU realize that many of us western readers have failed to express our thoughts in Our Readers Say, and yet we wonder why you don't print the kind of articles we want? We seem to take it for granted that you can read our thoughts, so we just rave to ourselves when we find our favorite article left out. I want more and more radio! My pal and I spend all our spare time working on our radios, and I know there are thousands of others that are as interested in radio as we are. The articles you are printing about radio are good but there aren't enough of them. All you radio fans please write the editor and help me beg him to print more articles on radio! Why don't you print an article on one-tube sets? I don't know about the rest, but I know I have more fun fooling with one-tube sets than I do with four- and five-tubers. But you can rest assured that whatever articles you print on the fascinating subject of radio will be thoroughly appreciated. I have often wondered how you always get the new ideas and inventions a month or two ahead of the other mechanical publications. Why not tell us how this is done?—E. T. H., Jr., Watonga, Okla.

"He" Bees and "She" Bees Are Now Properly Classified

THIS bee stuff, which has recently popped up in Our Readers Say, isn't a matter of sex. It's a matter of no sex. C. P. H., of Canaan, Conn., is just as dumb on the problem of sex in bees as is R. P. D. of San Antonio, Texas. If C. P. H. will do a little intensive studying, he will find that, through some paradox of nature, the worker bees have no sex, and are neither male nor female, but are termed neuters. The same situation exists in the ant family. The only "she" bee in the hive is the queen, and she doesn't work any harder than the "he" bee or drone. Her only duty is to propagate the hive. She has it luckier than the he bee, however, for at the end of the mating season, the drones



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Both work with long, smooth, tugless strokes—both hold the blade at the *same slant*—both slide through the beard at right angles—and both leave the face purring with comfort.

Gem's specially designed bevelled top duplicates the barber's stretching fingers, takes up the skin's slack, tightens it like a drum and brings every hair upstanding to be cut at root level.

We build Gem Micromatic Blades of fifty per cent thicker surgical steel—so toughly textured and tempered that they withstand without frazzling the 4840 separate stroppings we give them. This exclusive process produces a micromatically exact, deeply wedged edge—an edge which Dual Alignment (Gem's unique patented feature) holds in such perfect control that it can be used with even *greater* safety than duller, softer and thinner blades. Dual Alignment locks the blade unbudgingly on the guard at five separate points, and holds it so rigidly that it *can't* creep, warp or scuff a contour.

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Beautifully boxed sets at your dealer's for a dollar. Or a demonstrator outfit, with a regular dollar razor and a single- and double-edged blade, to any "doubting Thomas" who'll spend a quarter and send this coupon.

CLIP

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Gem Safety Razor Corp.,
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Enclosed find 25c for complete trial Gem set with a single- and a double-edge blade and the same gold-plated Gem Micromatic Razor now featured in regular $1.00 outfits.

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GEM MICROMATIC *Razor and Blades*

are killed by the workers, while the queen remains an honored member of the household. Let's hope that C. P. H. profits by this lecture. But then, maybe the bees in Connecticut are different from those in Iowa. Out here, however, the only female in the hive is the queen, as I supposed everyone knew.—E. C. B., Sioux City, Iowa.

Matter in Rotation Offers Some Interesting Tests

EXPERIMENTING with rotating matter I find, that once started, it tends to continue in rotation and as the speed increases, the mass moves in an ever larger circle, and tends to fly outward. As the speed declines, the rotating mass moves in an ever smaller circle, falls inward, and winds up at a central point. We can prove this by simply rotating a small emery wheel at the surface of a pail of water with dried beans or sediment at the bottom of the pail to show the action of the rotating liquid. In experiments with the rotation of rigid bodies, we find the metal thrown outward as the speed increases and we conclude that rotation tends to throw mass off at a tangent. But here we find that, since gravity holds the object to one spot on the revolving wheel, it cannot move uniformly outward as the rate increases, and hence does not give the whole story of rotation. Have any other readers made any experiments on this matter? I could add some of my own conclusions but they would occupy too much space and besides, I am anxious to get the opinions of others and see if they agree with mine.—E. M., Newport, Wash.

Steam Power for Planes and Cars Is His Interest

I SHOULD very much like to see another article on steam power for airplanes in the near future. I am anxious to know whether the motor which was developed out in California has been thoroughly tried out as yet. I also think an article on "Why We Don't Have Steam Automobiles" would make very interesting reading. I hope you can give us another article along this line soon.—A. D. F., Holston Valley, Tenn.

He Tells You the Secret of Keeping Up-to-Date

MY NEXT-DOOR neighbor just got back from the Chicago Auto Show. All he got out of it was the idea that the roads will soon be full of "funny looking" cars. I had read Robert E. Martin's article on the new streamlined stock cars in a recent issue of POPULAR SCIENCE MONTHLY, and was primed to tell him the whys and wherefores. After I got done giving the scientific reasons for the new lines and curves and the tests which led to their adoption, he wanted to know how come I knew so much about it. I showed him the article. He said: "Say, I better start getting that magazine!" So add another customer to your rapidly growing list. Keeping up-to-date is harder than ever and I don't know any better aid than your magazine.—G. N., Joliet, Ill.

New List of Favorite Articles We Published

IN ANSWER to R. A. of Columbus, O., as to the Readers' opinion of the ten best articles printed in 1933, I give mine: Auto Stealing New $50,000,000 Racket, (Jan.); Prehistoric Monsters Roar and Hiss for Sound Films, (April); Beer Making Is Marvel of Industrial Chemistry, (June); Tricks of Firebugs Exposed By Police Experts, (July); How Strange Disease Accounts For Army of Lost Persons, (Aug.); Mountain-Top Roads and Bullet Trains, (Aug.); Rare Stamp Racketeers Thwarted By Black Light, (Sept.); Animal Movie Actors Trained By Strange Tricks, (Sept.); Strange Inventions Used By Crooked Gamblers, (Nov.); Crack-up of Mighty Glacier Caught For First Time By Sound Camera, (Dec.). I expect there will be many exceptions to this list so let's see them.—C. R., Jr., New York, N. Y.

Mystery of Bouncing Bottle Cleared Up by Photographer

FOLLOWING is a brief discussion of the amateur photographer's picture of a bouncing milk bottle which you reproduced in a recent issue. While such pictures are interesting in themselves and a credit to the person who took them, their accuracy is open to question. The distortation, I believe, is due not to bending of the bottle, but to the manner in which the photograph was taken. Cameras working at shutter speeds as fast as 1/1,000th of a second employ focal plane shutters. The shutter consists of a curtain with a slot (or usually a selection of several slots of different apertures) which passes in front of the film with variable speed. The rated exposure is the exposure each portion of the film receives as the slot is passing in front of it. Most focal plane shutters move from top to bottom in the camera. Since the image is inverted, the lower part of a scene is exposed first and the upper part last. The shadow of the milk bottle, being lower, was recorded first, then the bottom edge, and on up to the top. From the shape of the bottle in the photograph, its motion can be analyzed as upward, with a canting to the right. The canting motion becomes apparent when one observes that the planes of the top and bottom of the bottle are not parallel, indicating that the bottle was at different tilts at the beginning and end of the exposure. The composite of these motions produces the result shown, that is, an apparent stretching and bending distortion.—D. P., Madison, Wisc.

Why Does Soap Make This Nail Brush Float?

I JUST made a discovery. When I have a nail brush well soaked in soap and water, I notice that it doesn't sink in the washbowl until all of the soap has gone off into the water. I think it was because the soap was porous. Does any reader have a different opinion?—W. L. S., Rome, N. Y.

Thinks Tungsten Razor Would Last Forever

SOME time ago, you published splendid articles dealing with facts about shaving and all kinds of razor blades. About the same time you also published an excellent article regarding vision and gave facts about lenses and the wearing of spectacles. I should like to see these articles revised to include all that science has discovered since that time, and reprinted in POPULAR SCIENCE MONTHLY. While on the subject of shaving, I should like to see an article on the various electric razors being introduced to the public at the present time. I have heard that if a razor blade were made from tungsten it would last forever. Looks as if some of the manufacturers should develop a blade of this type and offer it to the public, or would it cost too much?—D. N. C., Norfolk, Va.

Oblique Fall of Meteor Explained by This Reader

RECENTLY in your magazine, there was an illustrated article, and a photograph of a car hit by a meteorite which went through the hood and radiator. In a later issue I find in Our Readers Say that a gentleman disagrees that the car was hit by the meteorite. He says, "When I read the article I knew that it was not true, or the illustrator was in error, as meteorites that strike the earth descend in a vertical direction." Perhaps the above mentioned gentleman was thinking of Galileo and the center of gravity test, which is used by our surveyors and is known as the Plumb line. He is right as far as dropping dead weights and objects are concerned but that theory does not apply where moving objects are concerned. Perhaps I can convince some member of the Meteor Society if he or she should read this. For example, when you throw a stone or even a baseball high into the air the object will not come down in a true vertical line; or, shall I say if you fired a large field or mobile gun at an angle of sixty-five to eighty-five degrees, you would not expect the shell to stop abruptly at its estimated or given distance and fall straight down. It would continue, I say, on its angled course to the earth. The same applies to a bomb cast or released from an airplane. If such be the case, how could you expect a meteorite to fall in a straight line at the speed with which it is traveling through the stratosphere? This seems to me conclusive evidence.—L. S., New York, N. Y.

He Knew a Good Thing When He Saw It, But Conscience—

SINCE the middle of last August I have been hitch-hiking around, like a lot of other kids these days, and working at whatever I could get to do. While in Chicago, I visited the World's Fair. I was interested in your exhibit and also in a copy of The Pocket Guide to Science. I wanted a copy of that book pretty badly, but I had hitch-hiked from California and had no money and no job. So I just slipped a copy in my pocket and got away with it without paying for it. I've been working on a ranch near here for a while and although I am getting only my keep and a little spending money once in a while, I can spare the money now for the book. As I am sorry I took it and want to squeeze myself as a punishment, I am enclosing a dollar for it and hope it will be enough. While I regret the manner I came by it, I'm still glad I've got it!—B. O., Stanton, Tex.

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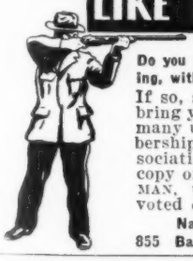

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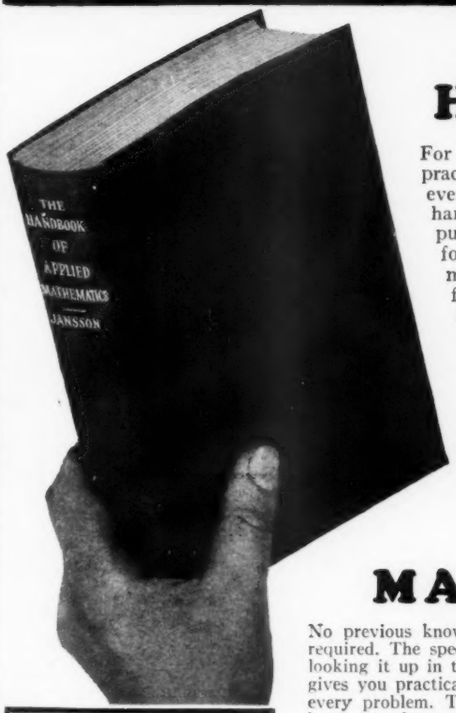

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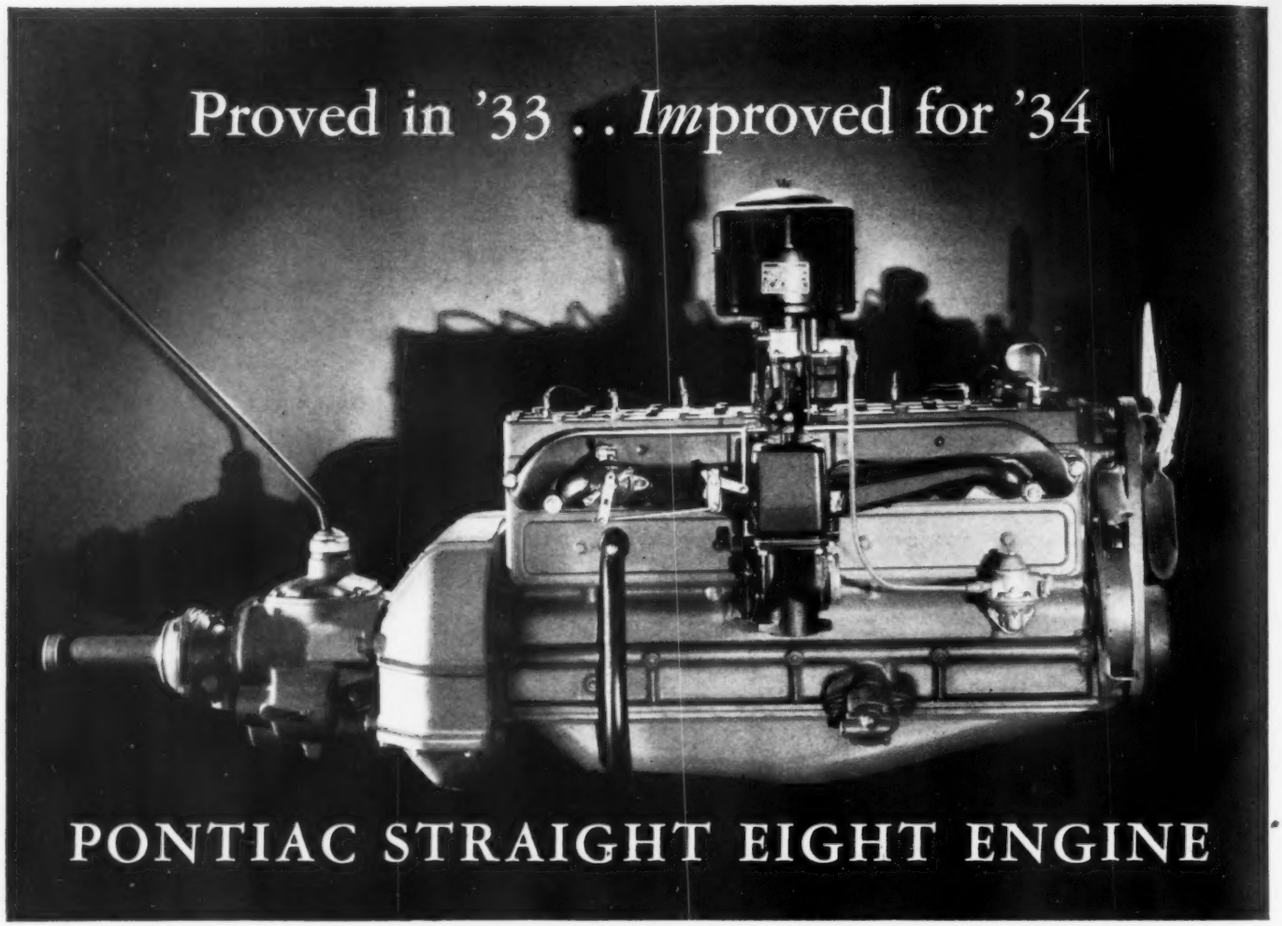
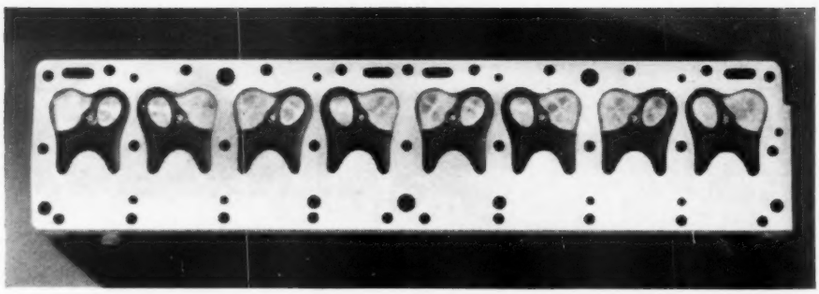


PONTIAC STRAIGHT EIGHT ENGINE

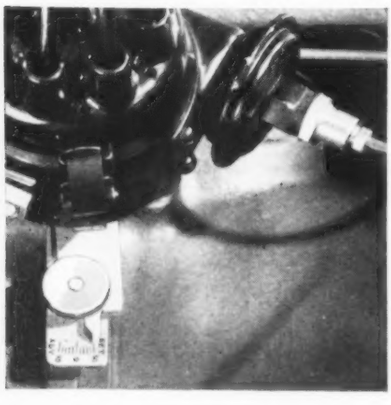
Develops Greater Power . . . Delivers More Speed . . . Burns Less Gas Per Mile

Last year's Pontiac motor was noted for its smoothness . . . its power, speed and economy. The power plant of the 1934 Pontiac, thanks to many engineering refinements, surpasses even its famous predecessor. Power has been stepped up to 84 h.p. . . . speed increased to 82 m.p.h. . . . yet the amazing Pontiac engine gives more miles to the gallon by a generous 10 per cent. As to *smoothness*, a prominent engineer states, "If you want more *smoothness* than you get in the Pontiac Straight Eight engine, you've got to go to a motor of more cylinders."



New High Compression Head, Shown Above, Increases Engine Efficiency . . .

The 1934 Pontiac engine uses a new and improved type of General Motors Research cylinder head with a compression ratio of 6.2 to 1. Directly above each valve, in the combustion chamber, is a metal boss or button. This cuts down the clearance space above the valves and brings the valve heads closer to the cooled roof of the combustion chamber. The major advantages of this cylinder head design are: a smoother and less restricted flow of incoming and outgoing gases in the combustion chamber, and also cooler valves. The extra water-cooled surface in the combustion chamber adds enough cooling effect to permit the use of a higher compression ratio (6.2) without necessitating the use of premium-priced, anti-knock fuels.



At Left—New Vacuumatic Spark Control and Gaselector

Credit for much of Pontiac's new fuel economy goes to its new system of controlling the spark (see device at right of distributor) by a vacuum created by the suction of the engine. This new method unerringly advances or retards the spark to obtain maximum power from minimum fuel at all speeds and loads. It responds *instantly* to the ever-varying requirements set up by the throttle. . . . The Gaselector, shown just below the distributor, permits setting the spark to obtain maximum efficiency from whatever grade of fuel is used . . . Pontiac Motor Company, Pontiac, Michigan.

GET A STRAIGHT EIGHT FOR YOUR MONEY!

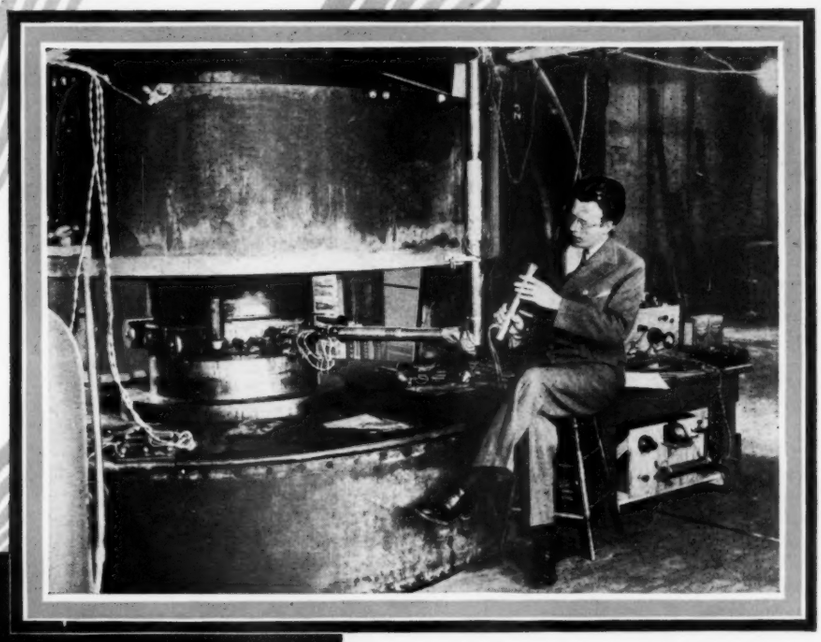
POPULAR SCIENCE
MONTHLY

April 1934 Vol. 124, No. 4

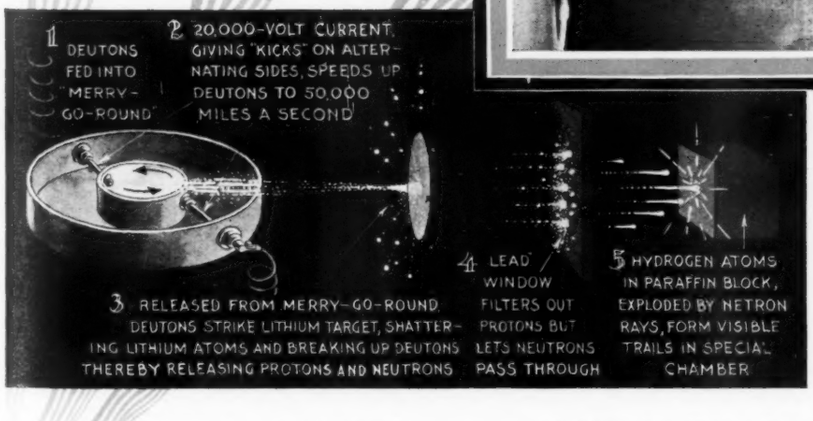
RAYMOND J. BROWN, *Editor*

New Mystery Rays

TAP POWER HIDDEN IN ATOM



Dr. E. O. Lawrence with the world's biggest electromagnet at the University of California. The magnet is used to produce neutron rays, the most penetrating ever created. Left, schematic diagram gives idea of method of producing neutron rays


1 DEUTONS FED INTO "MERRY-GO-ROUND"
2 20,000-VOLT CURRENT, GIVING "KICKS" ON ALTERNATING SIDES, SPEEDS UP DEUTONS TO 50,000 MILES A SECOND
3 RELEASED FROM MERRY-GO-ROUND DEUTONS STRIKE LITHIUM TARGET, SHATTERING LITHIUM ATOMS AND BREAKING UP DEUTONS THEREBY RELEASING PROTONS AND NEUTRONS
4 LEAD WINDOW FILTERS OUT PROTONS BUT LETS NEUTRONS PASS THROUGH
5 HYDROGEN ATOMS IN PARAFFIN BLOCK, EXPLODED BY NETRON RAYS, FORM VISIBLE TRAILS IN SPECIAL CHAMBER

By JOHN E. LODGE

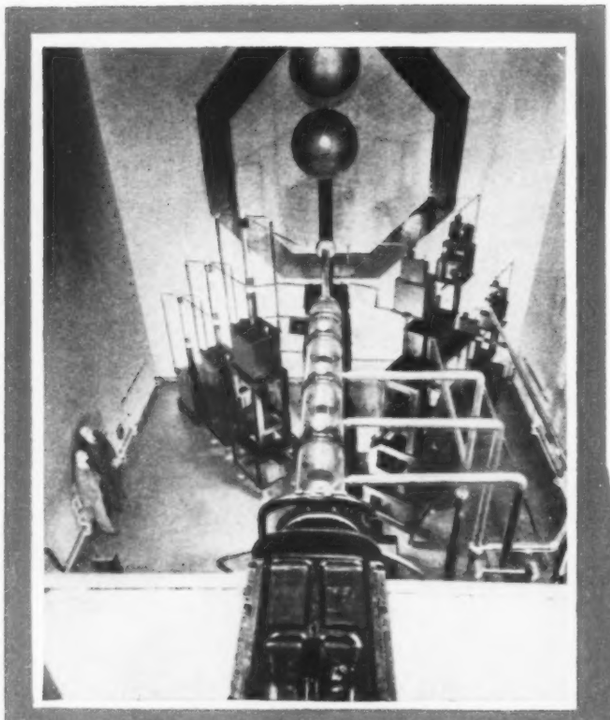
A MAGNETIC merry-go-round, firing electrified particles at 50,000 miles a second, has just generated the world's first neutron ray in a research laboratory at the University of California.

The new ray represents the culmination of years of study by two California scientists, Dr. E. O. Lawrence and Dr. M. Stanley Livingston. It is the most penetrating ray ever created in a laboratory, a giant brother of the X-ray and the gamma rays of radium. It has the anomalous property of penetrating heavy substances more easily than light substances. Thus, hydrogen, lightest of gases, is almost an impassable barrier, while the ray passes throught lead with comparative ease. Its practical possibilities at present remain unguessed.

Ten million neutrons a second stream through a lead window when the rays are being generated. Neutrons are the electrically dead particles which British physicists discovered two years ago when they blasted lithium atoms apart in a Cambridge laboratory. Until that time, it had been thought that atoms, the tinest bits of matter capable of existing alone, were composed solely of positively charged particles, called protons, and negatively charged particles called electrons. The usual concept of the construction of an atom has a group of electrons whirling around a central nucleus composed of a proton or group of protons as planets wheel about a central sun.

Everything in the world—men, machines, plants—are composed of these tiny units just as a wall is built up of bricks. Fifty trillion ordinary atoms can crowd together on the head of a single pin. From such inconceivably small storehouses of power the new ray obtains part of its energy.

In their work, the California physicists use the largest



Mercy Hospital, Chicago, has installed this 800,000-volt X-ray apparatus. The size of the giant machine can be estimated by noting the figures of the men who are standing below it

magnet ever made, a scientific Big Bertha that towers higher than a man's head and weighs more than thirty-five automobiles. Between the upper and lower halves of this magnet, each looking like an immense metal grindstone mounted on a vertical axis, the scientists slide a vacuum chamber having the appearance of a covered frying pan. Inside it is the merry-go-round, a container shaped like a pillbox and made of brass.

Into this pillbox, the men feed deutons, the central particles of the recently discovered heavy hydrogen atoms. These are formed almost entirely of a combination of electrically dead neutrons and electrified protons. With the magnetic field holding these particles on a circular course, a 20,000-volt current is applied alternately to opposite sides of the brass container.

These successive kicks, perfectly synchronized, whirl the particles faster and faster until they are spinning at fantastic speeds and have acquired as much energy as if hurled by 3,000,000 volts. At this point, they are released from the electric sling and propelled into a silver-white target of lithium, the lightest of the solid elements. The result is a shower of neutrons, issuing both from broken deutons and shattered lithium atoms. Thus, part of the energy of the penetrating rays is the result of cracking the atom.

This suggests sensational possibilities. In the long quest for atomic power, through tapping the energy stored in these invisible components of all matter, the main problem has been to find the right projectile to split apart the atom. The deutons used in California are the heaviest and most efficient bullets so far employed. The energy they return for the amount put in is greater than that obtained by any other method. If the workers can increase the energy obtained from shattering atoms without increasing the energy put into the work of breaking apart the electrons and protons, super-powerful and super-efficient rays may be created for remarkable work in the future.

At present, the two California scientists are engaged in careful tests, seeking to obtain a clearer picture of the ray they have created and of its possible applications.

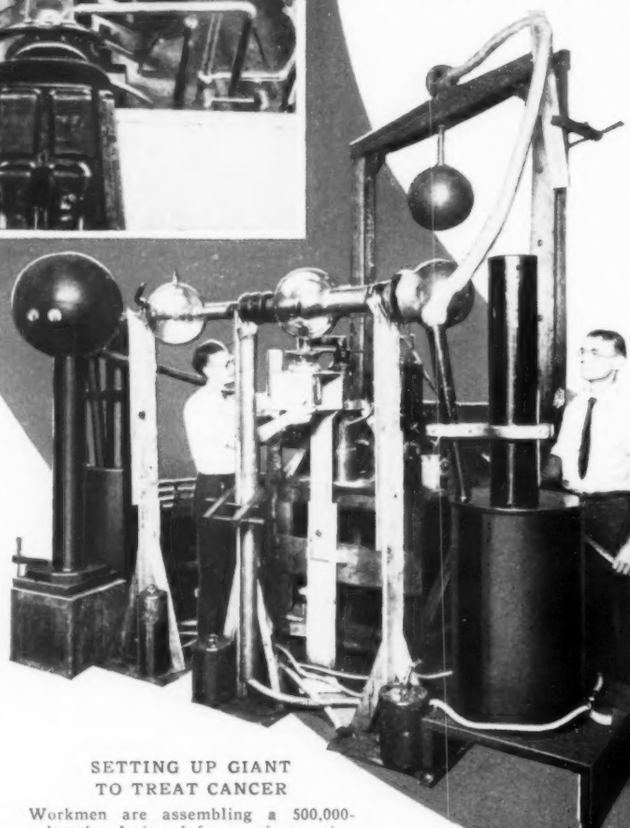
Because the neutrons carry no electric charges, they shoot through atoms undeflected by the "walls" of electricity which surround the central nuclei. Only when they make a direct hit are they stopped. Then their mass, 1,800 times that of an electron, bursts the atomic nuclei apart and sends off shooting particles far heavier than the electrons released by X-rays or gamma rays.

One experiment has shown that the new ray has the power of changing light chemical elements into heavy ones. When aluminum, for instance, was subjected to the neutron bombardment, its atomic weight increased. The neutrons, in this, instead of breaking up the nuclei, had joined with them, thus increasing their weight.

Blocks of paraffin, containing a high percentage of hydrogen, are being placed in the path of the rays. When the neutron stream hits them, it breaks up the hydrogen atoms, setting free a shower of particles with trails that can be seen and counted in a special chamber. In one test, these trails indicated that 10,000,000 neutrons a second were streaming from the magnet and bombarding the paraffin. In fact, it was this display of atomic fireworks that first proved to the experimenters that they had created the ray.

Because the human body is two-thirds water and its hydrogen content is high, the effect of the new ray in treating disease remains to be determined. At all events, its penetrating power, even through hydrogen, is greater than any tool now at the disposal of the radiologist, as the expert is called who uses X-rays and radium to perform modern feats of scientific magic.

At the same time that the new ray is reported from California, word comes from Europe that Prof. F. Joliot and his wife,



SETTING UP GIANT TO TREAT CANCER

Workmen are assembling a 500,000-volt tube designed for use in treating cancer. Dr. W. D. Coolidge, director of the General Electric Laboratory, devised the system employed in this giant

Candy, sealed in boxes, is inspected by means of this X-ray apparatus. Bits of metal are thus instantly found

• *INVISIBLE FORCES, RECENTLY DISCOVERED, LEAD*

Irene Curie-Joliot, the daughter of the discoverers of radium, have, for the first time in history, produced artificial radioactivity. By bombarding aluminum, magnesium, and boron with positively charged particles traveling 18,000 miles a second, they caused the targets to give off radiations similar to those of radium.

New developments in X-rays and new uses for radium are constantly widening the field of the radiologist, who now works not only in the hospital and surgeon's office but at the factory, the foundry, the arsenal, the art gallery, and the police laboratory. His invisible rays are solving mysteries, preventing accidents, diagnosing ills both human and industrial.

One of the most amazing of all feats of X-rays occurred not long ago in an eastern city. To study the action of an ailing heart, a surgeon made a tiny opening in a vein of a patient's arm and inserted a rubber tube hardly thicker than a hair. He carefully worked it up the vein to the neck and down an artery to the heart itself, all the time following its progress by means of X-rays.

With the end of the tube actually inside the vital organ, he injected through it a metallic element which revealed the changing outline of the heart in all its details and enabled him to make a thorough diagnosis. Then, he cautiously pulled the tube back up the artery and down the vein and closed the opening in the arm!

In other cases, metallic substances that register sharply on an X-ray negative are injected directly into the bloodstream so the action of the veins and arteries can be studied by the diagnosing doctor.

Dr. M. Stanley Livingston, left, and Dr. E. O. Lawrence, right, with the eighty-six-ton electromagnet they have used in making their experiments with the mysterious neutron rays. At lower left, diagram shows construction of magnet

At Beth Israel Hospital, in New York City, "X-ray talkies" are now filmed to help doctors study diseases of the heart. While the apparatus snaps pictures, making them in 1/120th of a second, a miniature microphone within a stethoscope transforms the sounds produced by the contracting of the heart and the snapping of the valves into electrical impulses which move a lever in a beam of light and thus create a sound track on the film, perfectly synchronized with the pictures. By a comparison of sound and picture, the expert is able to find the exact point in the heartbeat where an abnormal sound occurs. This is of great value in making a diagnosis and laying out a course of treatment.

That modern X-ray apparatus literally can find a needle in a haystack was demonstrated, a few months ago, by engineers at the General Electric Laboratory, in Schenectady, N. Y. They placed a small needle at the center of a bale of pressed hay, five feet high. When the X-ray film was developed, it showed the exact location of the bit of metal.

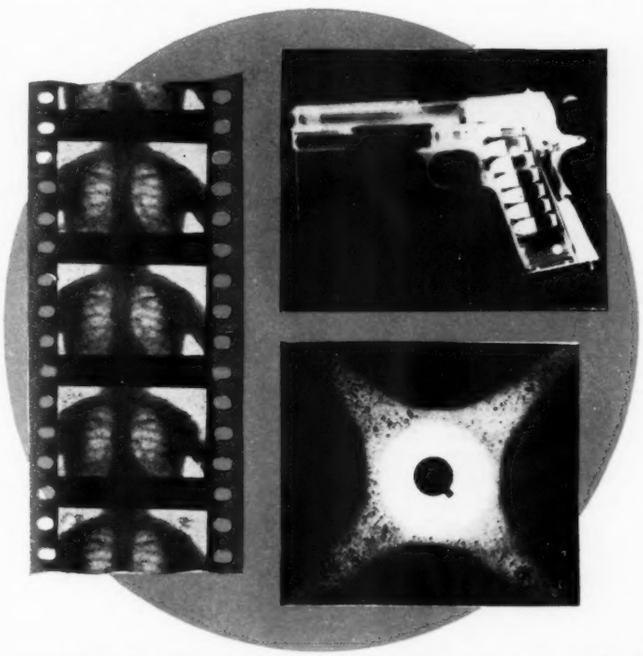
To the average person, the operation of these miracle machines is still a mystery. How are the rays formed? How do they penetrate solids? How do they make pictures? How do they aid in curing disease?

New machines range from 800,000-volt giants, giving as much radiation as $75,000,000 worth of radium, to midget tubes that barely reach across the palm of the hand and function in machines that can be plugged into an ordinary light socket. Most of them operate in the same way. Take, as an example, the new 800,000-volt apparatus installed in the Mercy Hospital in Chicago.

It has a battery of four glass vacuum tubes having an overall length of fourteen feet. At one end is a coil of tungsten wire about the size of a postage stamp. This forms the cathode (negative electrode), reaches a heat of from 2,300 to 2,500 degrees and sends off a stream of negatively charged particles which form the cathode rays. At the other end is a round water-cooled tungsten target, positively charged. Magnets steer the cathode rays down the fourteen-foot tunnel of glass to hit this four-inch bull's-eye.

As the cathode rays hit the target, they change into X-rays, just as the energy of a bullet turns into heat on stopping suddenly in hitting a steel wall. These X-rays shoot out of the tube in all directions but shields of lead prevent their escape on all sides except the one on which the patient or object being examined is placed.

An expert, simply by looking at a tube in action, can tell you whether it is giving off "hard" or "soft" rays. The soft rays give the greatest *(Continued on page 120)*

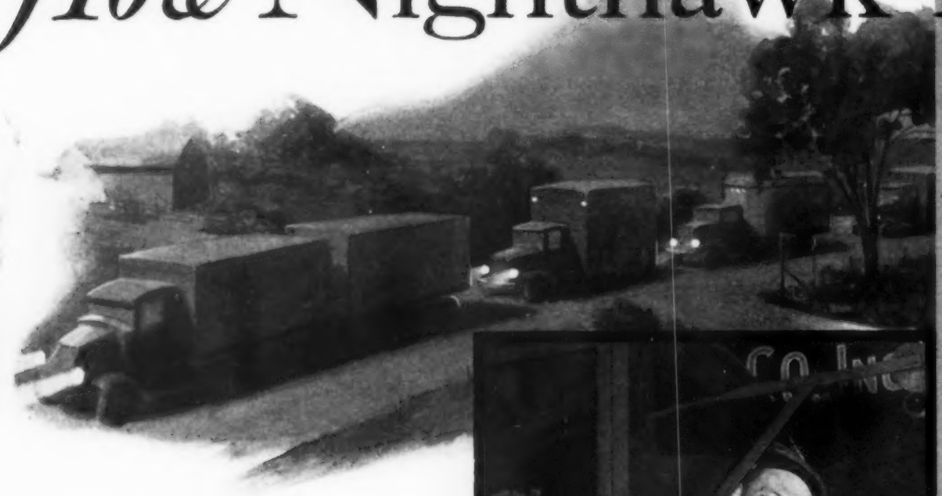


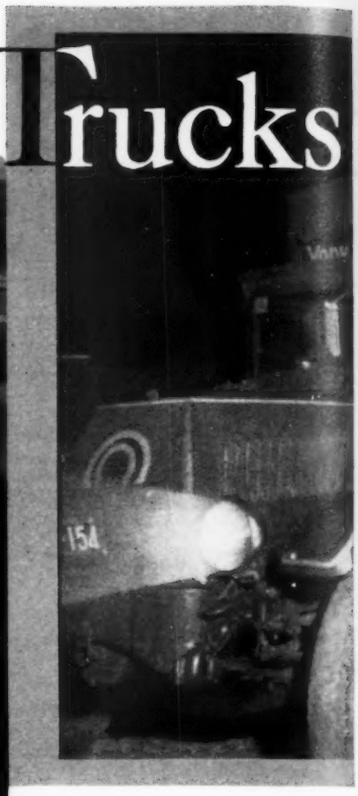
HIDDEN SECRETS REVEALED BY THE X-RAY

At far left, movie strip of human lungs made with modern, high-speed X-ray. Upper left, automatic pistol as seen by X-ray. Below it, an X-ray picture of a car's steering wheel showing defects in metal

SCIENTISTS INTO REALM OF UNEXPLORED MARVELS •

How Nighthawk Trucks





Sleepy Ulrich, driver of the truck and trailer, knows every traffic light betweeen York, Pa., and Manhattan

Tickets covering consignment

By EDWIN TEALE

THREE million trucks roll on the eight million miles of surfaced roads in the United States. In all parts of the country, hundreds of thousands of machines take to the highways when darkness falls, speeding over hills and valleys, heading for the larger cities. While the cities sleep, this vast, unseen caravan transports bread and flowers, milk and steel, eggs and high explosives.

Recently I rode on a 200-mile overnight run across Pennsylvania hills and New Jersey highways from York, Pa., to New York City to watch first-hand the operation of a fast modern highway express.

The trip began at the York terminal. "Sleepy" Ulrich, the driver, was painting the big chains on Truck 35 with oil as I crossed to the end of the long shed.

Behind us, a dozen men toiled in the glare of the loading platform. Boxes, barrels, crates, bundles were being packed into the huge bodies of trucks and trailers. Tailboards slammed. Motors barked and roared. Machines lumbered away into the darkness, heading north, south, east. The night fleet of the York Motor Express was beginning to roll.

Ulrich finished his last-minute job, carefully hung his brush on a hook under the truck, stowed his pail of oil, looking like black molasses, in a rack on the running board, and we both climbed up into the cab.

Our load was ready. The "tickets" covering the consignments were handed up in an oilcloth pouch. Fifteen tons, including 10,000 nickel cigars, two dozen guinea pigs, wallpaper piled like cords of stovewood, a crate of yelping collie pups, and an anchor chain for a steamship, were riding on the eighteen balloon tires of our truck and trailer.

We were more than a fifth of a block long as we pulled out of the shed, rolled down a dark alley, and turned into the glittering main street of York. Sleepy looked at his watch. It was nine P. M. For six years, he has been pulling big loads out of York. For fifteen, since he was a marine in the World War, he has been handling trucks. Built like a Minnesota fullback, he weighs 220 pounds, has a slow, good-natured grin, and is rated one of the crack trailer men of the East.

For five minutes, we worked our way through traffic, along residence streets past silk mills luminous with the blue light of mercury-vapor lamps, out to the suburbs. Then we settled down to the long grind. The roar and clatter of the big engine filled the cab. We were hitting thirty-five miles an hour, making time on the level road to Wrightsville and the bridge across the Susquehanna.

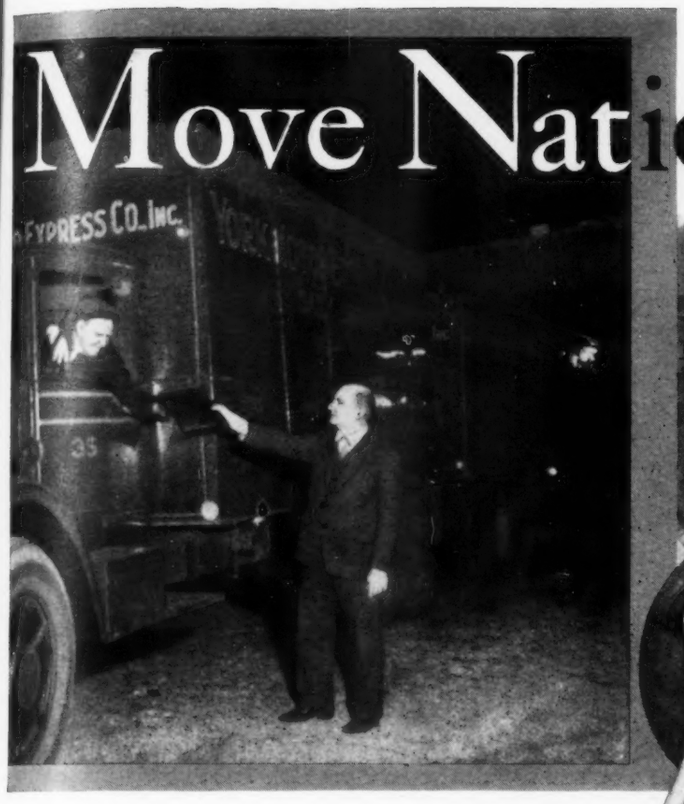
Truck transportation, in the last few years, has grown to major importance. In less than a decade, the number of machines traveling American roads has tripled. In 1921, it was under a million. In 1928, it had passed the three million mark. Single companies now have fleets of from 8,000 to 14,000 trucks and more than forty fleets of 1,000 or more machines are in the country. At present, three fifths of all the trucks in the world operate on the streets and highways of the United States.

They carry coal, sprinkle streets, haul garbage, put out fires, deliver newspapers, remove ashes, and accomplish a thousand and one other tasks demanded by modern civilization. Last year, for instance, more than 100,000,000 quarts of milk came by truck into New York City. Throughout the country, during the same twelve months, 7,000,000,000 pounds of livestock went by truck from farm to city. Forty-two percent of all shipments of hogs, sheep, cattle, and calves now roll to market on rubber tires; only fifty-eight percent going by rail. In the two years between 1930 and 1932, alone, there was a thirty-five percent jump in this total.

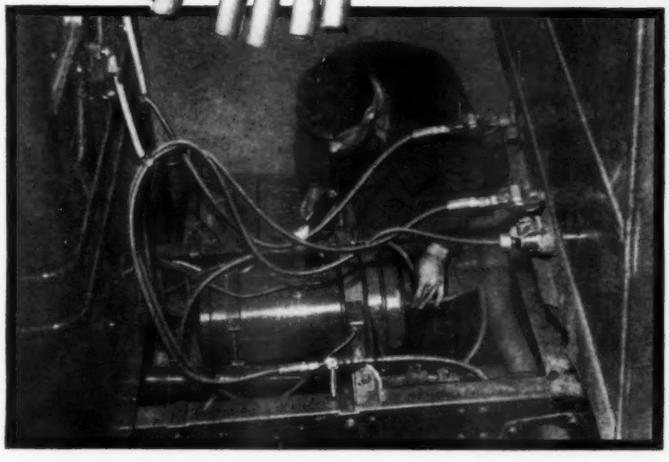
Outside our cab, a cold wind rushed past. But we were snug and warm. The heat inside can be regulated and in emergencies can even be raised to melt sleet from the windshield. Above my right shoulder, on the wall of the cab, are six flares, like long Roman candles. Every truck in Pennsylvania is required by law to carry such red lights for use if stalled on the highway. Each flare burns for fifteen minutes.

A few years ago, before this law went into effect, Sleepy witnessed not far from Coatesville, the strangest accident he has ever seen. A big truck loaded with cylinders of compressed oxygen had broken down and was stalled by the roadside. While the driver worked over the engine, a second truck, coming from the rear, crashed into it. The impact exploded the compressed gas, shattered the truck as though by a blast of dynamite, and tossed the heavy steel cylinders, split open like burst frankfurters, in all directions.

Move Nation's Goods



of goods are put in oilcloth pouch and given to truck driver



Above, placing red flares on the highway to warn traffic of a stalled truck. Upper left, group of flares which the laws of Pennsylvania require every truck to carry and light if truck stops

At left, the automatic mechanism between the truck and trailer. If the air and electric connections break apart brakes on truck and trailer are automatically set to stop them

Strangely enough, neither driver was seriously hurt by the accident.

At the toll house of the new Wrightsville-Columbia bridge, we pull up with a hiss of released air from the brakes. Every one of the eighteen wheels has its own air brake, enabling the driver to stop almost in his tracks. Sleepy fishes the three-dollar toll from his pocket. Off again, we cut around a furniture van with five red lanterns strung across its back, and then bowl along for a mile and a quarter over the white concrete spanning the river.

Beyond Columbia, we begin to climb out of the valley and it is hills all the way. Five-Mile Hill, Three-Mile Hill, Poorhouse Hill. We labor up one side and plunge down the other. The trailer, more heavily loaded than the truck, butts us as we slow down, jerks back as we speed up. When the trailer is full and the truck almost empty, Sleepy says, you need spurs to stick on.

"Do you know why truck drivers all wear suspenders?" Sleepy asks. I make a guess but it is the wrong one. "It's to keep their shirt tails in. If you wear a belt on a pitching truck, your shirt tails keep coming out all the time?"

Just west of Lancaster, we meet the "Philly Turnaround." It is a truck with a detachable body: The driver has taken one load to Philadelphia, unhooked it body and all, attached another and is making the return trip, all in less than ten hours. He blinks his lights, down and up like a man tipping his hat, and Sleepy answers with two yips of his horn.

Each year, the eighty-eight trucks of the York company burn almost 600,000 gallons of gasoline and travel a distance nearly equal to a hundred trips around the world. At the end of every run, mechanics go over the big machines as though they were airplanes of a transport line. One man is responsible for the greasing; another goes over the tires; a third is in charge of the gasoline and oil; a fourth spends all his time testing and fixing brakes. The final checkup is in the hands of the driver. He examines the batteries, the brakes, the eighteen-gallon radiator, the oil and the tires before the start.

Even so, the jinx sometimes catches up with him. A few nights before my ride, Sleepy had three flat tires in succession. Then both headlight lamps went bad. And finally the engine stopped and he found dirt in the carburetor! To take care of such emergencies, he carries a flashlight and a wide variety of spare parts, as well as a valuable assortment of tools of his own, for making special repairs. For him, tinkering with the truck is fun. Sometimes, he even spends his spare time around the shop working on Thirty-Five which has been his truck since it was purchased two years ago.

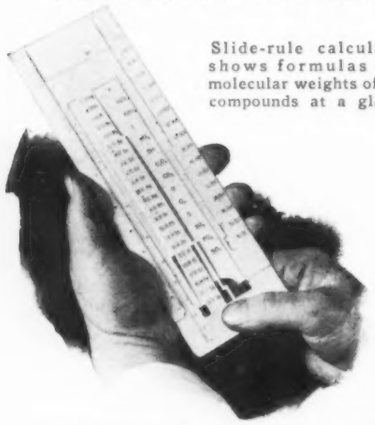
Almost never, however, does mechanical difficulty delay a load for more than a few hours. As a result, the fast overnight service permits goods to be transported to distant cities between closing time of factories one night and the opening of business places the next morning. A new kind of long-distance manufacturing has sprung up as a result.

By the time we reach Lancaster, the houses are dark. Few people are on the streets. We roar through canyons between high buildings, past a huge red-brick factory with twin *(Continued on page 118)*

TRUCK AND TOURING CAR COMBINED

DEVELOPED for use by surveyors, and possibly by the Army as well, a combination truck and touring car has just been perfected. Among its unusual features is a four-wheel drive, which is said to increase its ability to travel rough roads such as deep sand, steep hills, and ditches. On level highways it has a 65-mile an hour speed. Its engine develops 106 horsepower.

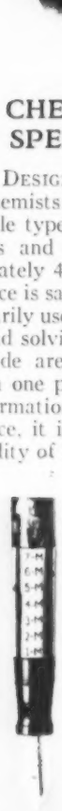
Rear view of combination touring car and truck, showing the manner in which a motorcycle can be loaded. Right, truck used as a passenger car



Slide-rule calculator shows formulas and molecular weights of 400 compounds at a glance

CHEMIST'S SLIDE RULE SPEEDS CALCULATION

DESIGNED for the use of commercial chemists and students of chemistry, a slide-rule type calculator shows correct formulas and molecular weights for approximately 400 inorganic compounds. The device is said to reduce greatly the time ordinarily used in computing molecular weights and solving equations. The holder and the slide are so arranged that the openings on one part conceal or reveal various information on the other part. With the device, it is possible to determine the solubility of a compound in water and acids.

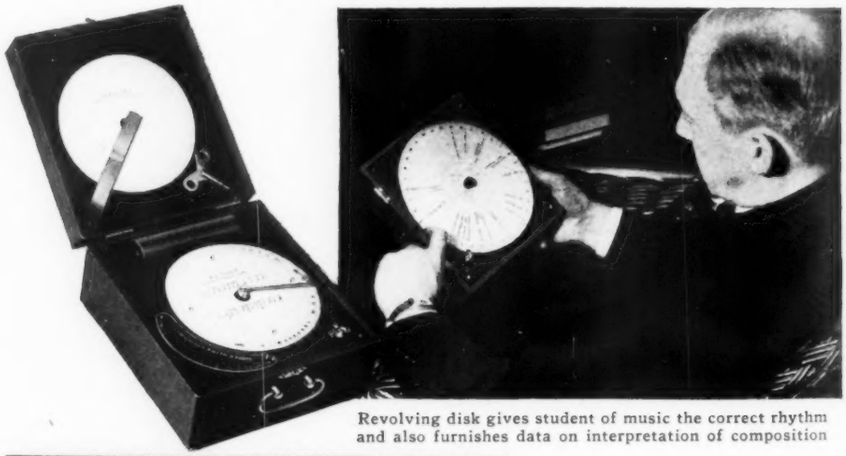


WORD TALLY ON FOUNTAIN PEN

WRITERS are able to estimate closely the number of words they have written by referring to a scale engraved on the transparent ink barrel of a new fountain pen. Seven sections are marked on the scale indicating the words written from 1,000 to 7,000. The point at which the ink in the barrel touches the scale, indicates the number of words written.

MUSIC TAUGHT WITH WHIRLING DISKS

CIRCULAR paper disks, revolving as a phonograph record does on its turntable, supply new methods of music instruction in the devices shown below, invented by Dr. W. Otto Miessner, composer and music authority of Chicago. In the "rhythophone," shown at the left, punch holes are made in the disk to correspond with the notes of a musical passage. As the disk revolves, an electrical contact is made each time one of the punch holes passes beneath the radial arm, and the correct rhythm of the passage is sounded. On the disks supplied with the other device are printed interpretations of the themes and motives of various compositions.



Revolving disk gives student of music the correct rhythm and also furnishes data on interpretation of composition

Engineer adjusting one of the twenty 100,000-watt tubes used in the world's biggest radio station

GIANT RADIO PLANT MEETS FIRST TESTS

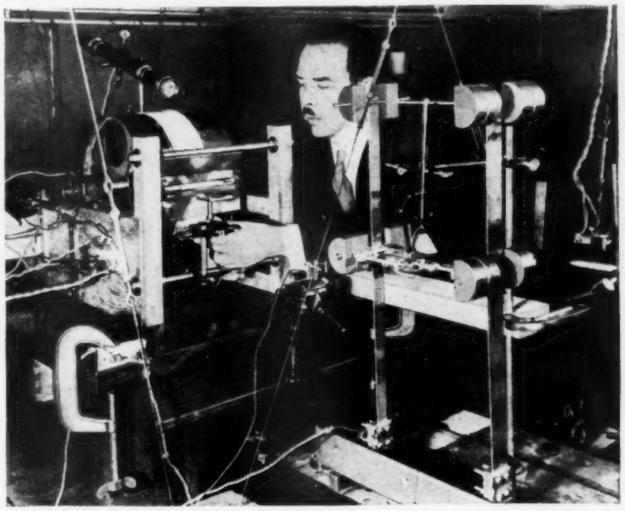
USING twenty 100,000-watt tubes, the biggest radio broadcasting plant in the world is now sending out test programs from Cincinnati between one and six o'clock in the morning. The station has a total power of 500,000 watts. Its giant tubes, water cooled, use a million gallons of water a day. In its initial tests, reports indicated that reception was good at points as far away as Alaska, the Canal Zone, and England. It is now believed the station will be audible at any point in the world.

UNIVERSAL WRENCH FITS MANY DIFFERENT NUTS

FITTING any nut, from a quarter of an inch to more than two inches in size, a universal wrench of European invention combines in one tool the functions of a large variety of wrenches and pliers. When the new wrench has been adjusted, pressure on a hand lever causes the jaws to seize the nut with a vise-like grip.

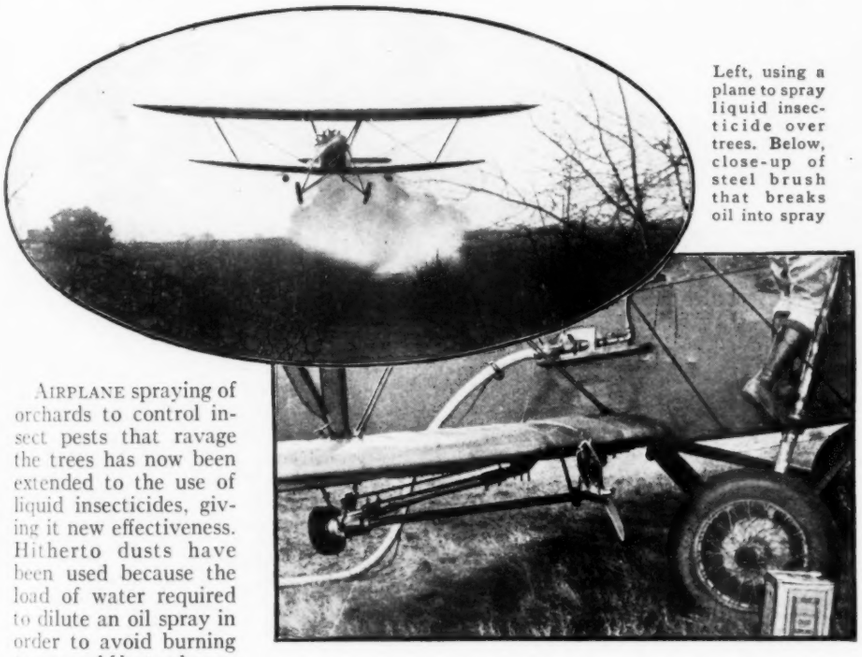
MEASURE STRESS CAUSED BY QUAKES

KNOWN as a stress recorder, a device recently placed in service at Harvard University, will aid engineers in the design of structures that will withstand earthquakes. When miniature building frames are subjected to artificial earthquakes in the laboratory, the device indicates the stresses to which each member is subjected, and from these figures the corresponding stresses that would be induced in a full-sized building can readily be computed and guarded against.



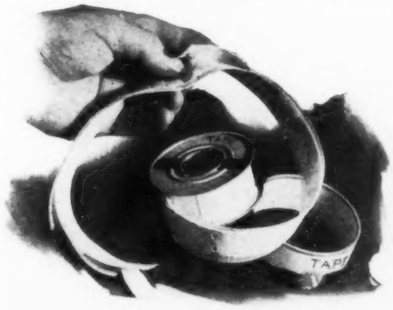
Apparatus used to record earthquake stress on members of model building

PLANE SPREADS INSECT-KILLING SPRAY



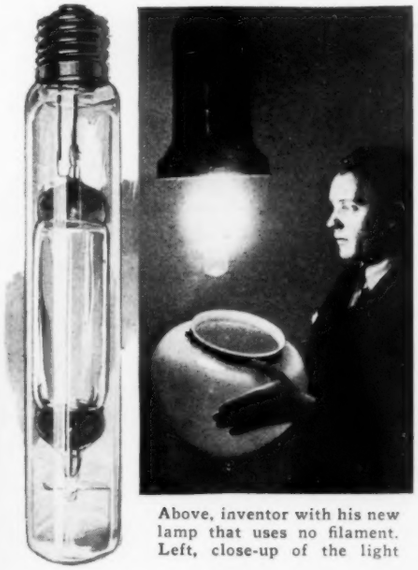
Left, using a plane to spray liquid insecticide over trees. Below, close-up of steel brush that breaks oil into spray

AIRPLANE spraying of orchards to control insect pests that ravage the trees has now been extended to the use of liquid insecticides, giving it new effectiveness. Hitherto dusts have been used because the load of water required to dilute an oil spray in order to avoid burning trees would be too heavy to carry in an airplane. A new air-spraying device, however, dispenses with the use of water by breaking the oil into a mist so fine that it will not be injurious to vegetable growth. This is accomplished by feeding the oil into a steel brush that is whirled at high speed by the revolutions of its propeller. One such brush is mounted beneath each wing of the plane in the manner shown, and the pilot controls the volume and distribution of the spray by means of valves in his cockpit.



SURGICAL DRESSINGS WOUND ON A SPOOL

SIXTY dressings for minor wounds are supplied in spool form in a first-aid package recently placed on the market. Readily detached for instant use, each dressing combines a strip of adhesive tape and pad of gauze, making it unnecessary to lose time in searching for the separate materials. The spool is packed in a dustproof case that may be dropped in tool kit without damage to the contents.



Above, inventor with his new lamp that uses no filament. Left, close-up of the light

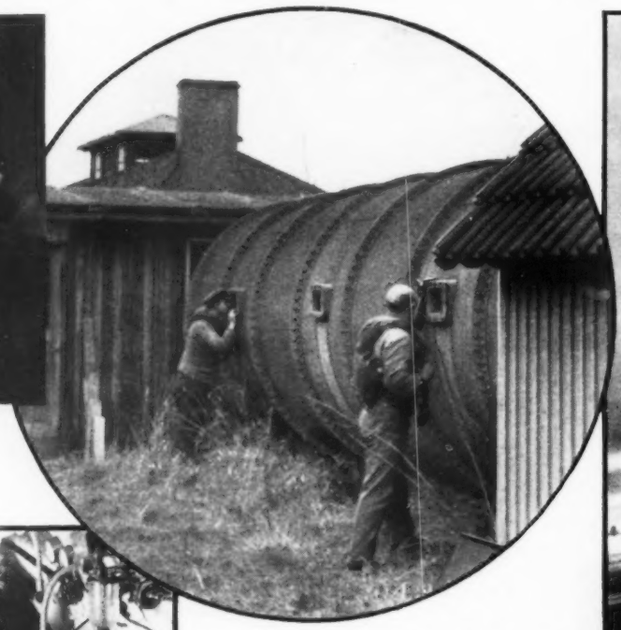
NEW ELECTRIC BULB HAS NO FILAMENT

DEVOID of any filament, an electric lamp demonstrated recently in New York City provides economical light by a new application of the glow of mercury vapor. Two bulbs are used, one within the other, and the space between the two is exhausted of air by a vacuum pump. The inner tube contains at either end, the electrodes that cause the lamp to glow. Invented by a German engineer, H. J. Spanner, the new light is a development of his "glow lamp" previously described in this magazine (P. S. M., Apr., '33, p. 40).

ODORLESS ANTISEPTIC

ODORLESS and tasteless, a new antiseptic compound, whose discovery is reported to the Society of American Bacteriologists, is described as a more effective germicide than iodine. The drug, a chlorine compound, has a bright yellow color, which persists as long as it is active.

Sub's Rescue Mask Tested on Land



This land submarine was built to test a rescue mask. Men watch the effect of air pressure. Upper left, under-water mask

Wearing rescue mask and jacket, workers inside submarine are ready to effect their escape

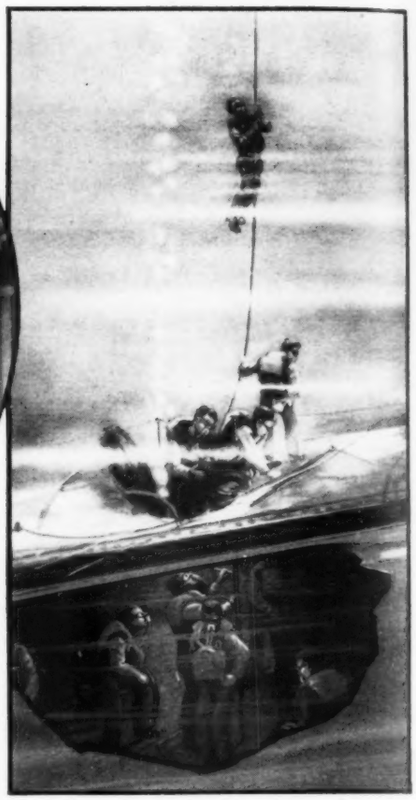


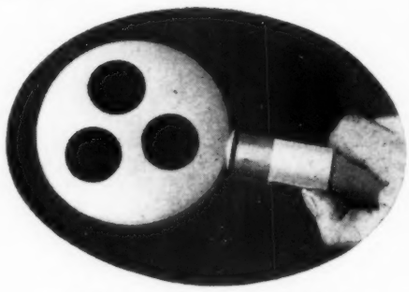
Illustration shows how man wearing the rescue mask would rise on cable to sea's surface. Note crew coming through hatch

To TEST a new breathing mask for submarine rescue use, a German manufacturer has erected a complete model of a submarine behind his factory. Men wearing the masks and special jackets enter the dry-land submarine, which is fitted with machinery and bunks to simulate a real craft, and carry out the drama of sailors escaping from a disabled submarine. Meanwhile observers watch the operation through glass windows set in the side of the model boat. Tests already made are said to have shown the practicability of the new mask, which includes an oxygen tank and a mouthpiece through which the wearer breathes, while a nosepiece closes his nostrils and goggles protect his eyes. Donning these masks, members of the crew of a disabled submarine could escape one at a time through a hatch and make their way to the surface along a cable that would have been made fast to their craft by divers of a rescuing party. The jacket used with the mask enables the wearer to withstand the pressure of the water until he reaches the surface, as has been established by experiments under various pressures in the test chamber.

NEW FREE-WING PLANE CAN'T STALL

Wings on this plane are pivoted to the fuselage one-third of their width back from leading edge. Tilting the wing prevents a tail spin

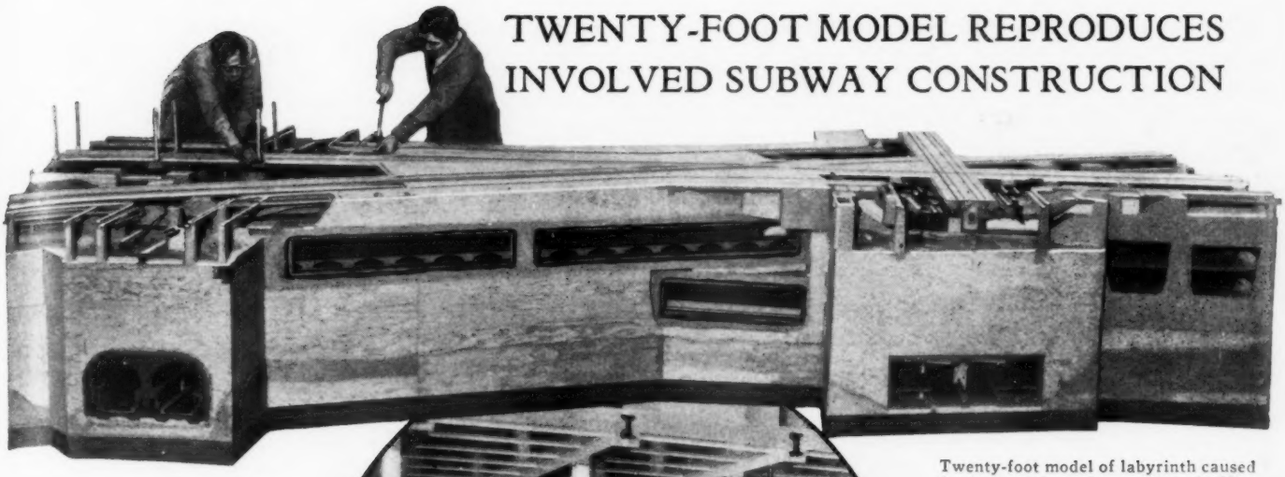
STALLING and tail spins are said to be prevented in a new type of airplane demonstrated the other day at a Los Angeles, Calif., airport. The wings are pivoted to the fuselage at a point one-third of their width from the leading edge, and the pilot may release them in flight so that they will tilt to counteract a dangerous spin. With the coördination between wings and tail surfaces, the craft rights itself automatically and thus prevents a spin.



HAND LAMP PROTECTS BLIND PEDESTRIANS

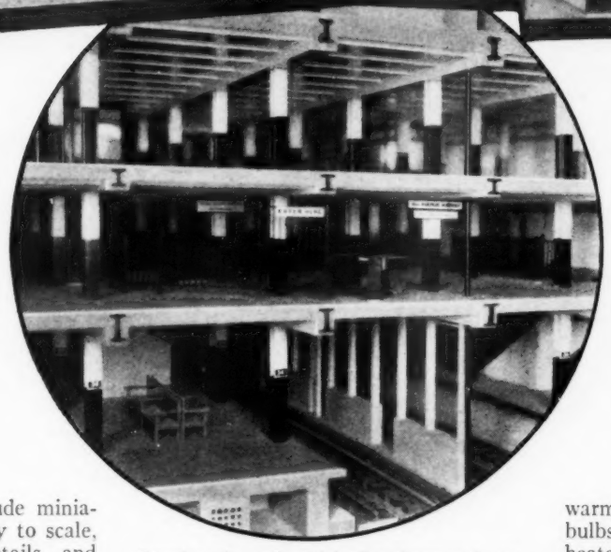
TO GUARD the lives of blind pedestrians at night, a hand signal lamp has been devised by a Belgian inventor. When the user crosses a street after dark, he holds up the pocket lamp and presses the button, lighting a luminous white disk on which three black dots appear. The inventor urges placing this signal in general use among the blind, so that motorists will instantly recognize it.

TWENTY-FOOT MODEL REPRODUCES INVOLVED SUBWAY CONSTRUCTION



Twenty-foot model of labyrinth caused by intersecting subway routes in New York. The model is nearing completion

Two New Jersey men are completing a twenty-foot model of the most complicated underground construction project ever attempted by man, selected by the Franklin Institute of Philadelphia for reproduction in miniature. The spot chosen is the New York City block bounded by Broadway, Sixth Avenue, Thirty-Third and Thirty-Fourth Streets, where existing and projected subways will create a subterranean labyrinth. The completed model, containing half a million individual parts, will include miniature subway trains built exactly to scale, and including the smallest details, and will reproduce the lighting effects.

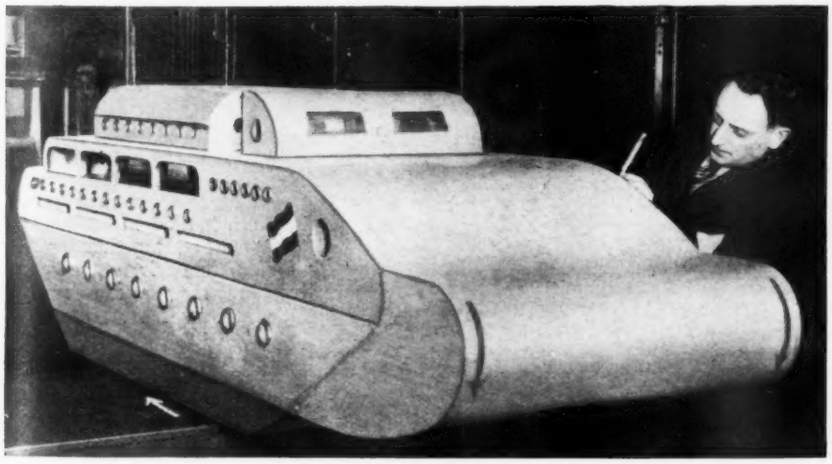


Interior view of model of underground construction, showing the maze of subway lines

CHICKS RUN THEIR ELECTRIC HEATER

BABY chicks may keep themselves warm with the aid of an automatic heater recently placed on the market. Shown below, it provides a platform to which the chicks are attracted by a pilot light burning continually at the rear, in center. The weight of several chicks on the platform closes a mercury switch and turns on two heater bulbs at the sides of the pilot. When the chicks get warm and leave the platform, the heater bulbs go out automatically. Thus the heater is connected to a wall socket and the chicks do the rest.

NEW RIVER BOAT HAS UNUSUAL DESIGN

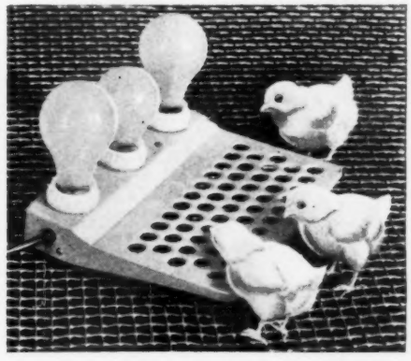


Model of a streamlined boat, designed by a Dutch engineer. It is intended for use on inland waterways and its inventor says it will be capable of unusually high speeds

A DUTCH engineer, C. J. Stoel, has embodied his ideas of the streamlined speedboat of the future in the ambitious model illustrated above. Designed for swift travel on lakes and rivers, its rolling lines afford an interesting comparison with the streamlined ocean liner described on another page of this magazine. The inventor is shown applying the finishing touches to his model, which measures more than six feet long, and illustrates how the craft will present a smoothly curved surface, devoid of projections that would cause wind resistance.

GASOLINE FROM SAWDUST

SWEDEN has just granted a subsidy of $50,000 for the erection of an experimental factory for the production of gasoline from peat and sawdust. A Finnish chemist invented the new process.



As chicks gather on this platform, their weight moves switch and turns on the heat

OIL-CAN OPENER ALSO A SPOUT

MOTOR oils may be poured into the crank case of a car directly from their cans through a combination can opener and spout invented by a Los Angeles man. The spout contains a sharp point that cuts a hole in the can. Oil flows out the hole and down the trough provided by the device.

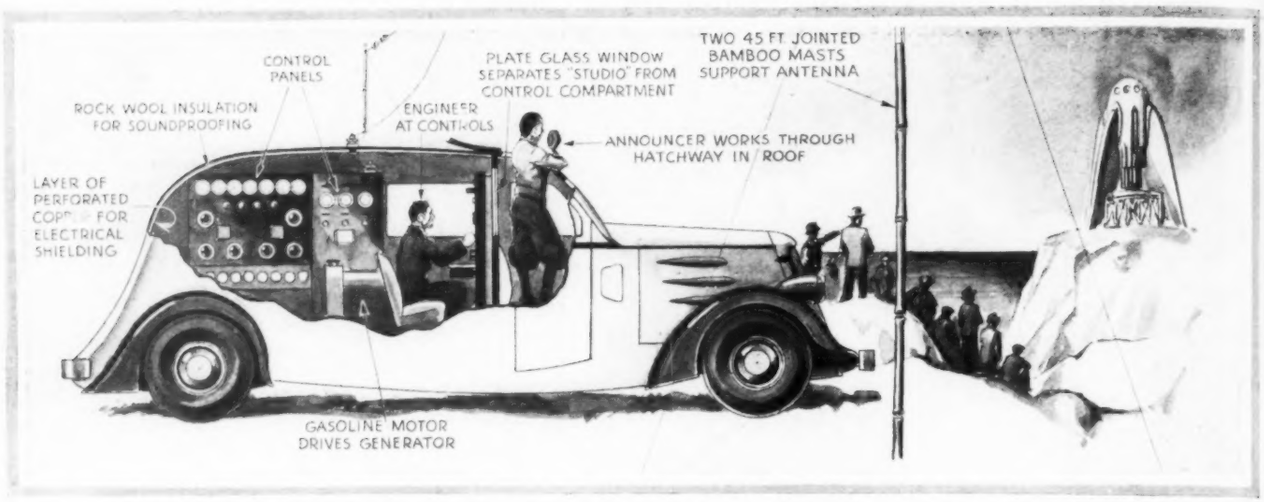

CONTROL PANELS
PLATE GLASS WINDOW SEPARATES "STUDIO" FROM CONTROL COMPARTMENT
TWO 45 FT JOINTED BAMBOO MASTS SUPPORT ANTENNA
ROCK WOOL INSULATION FOR SOUNDPROOFING
ENGINEER AT CONTROLS
ANNOUNCER WORKS THROUGH HATCHWAY IN ROOF
LAYER OF PERFORATED COPPER FOR ELECTRICAL SHIELDING
GASOLINE MOTOR DRIVES GENERATOR

Illustration of radio car showing how it would be used to cover news events by driving right to the spot

Whole Radio Station in Auto

Broadcasting from Scene of News Event Is Now Possible

When the car is barred, one of the crew goes in with this transmitter on his back and sends out his reports by use of ultra-short waves

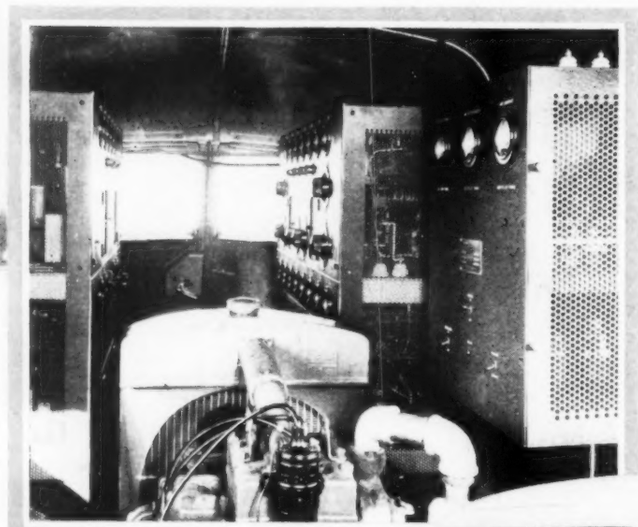
SPEEDING after the news at a mile-a-minute pace, a streamlined car about to be placed in service by the National Broadcasting Company will represent an innovation in radio technique. It contains a complete broadcasting station that can operate fifty to 100 miles from the nearest land line, bringing special programs of news and sporting events to radio listeners from virtually any point to which the car can be driven.

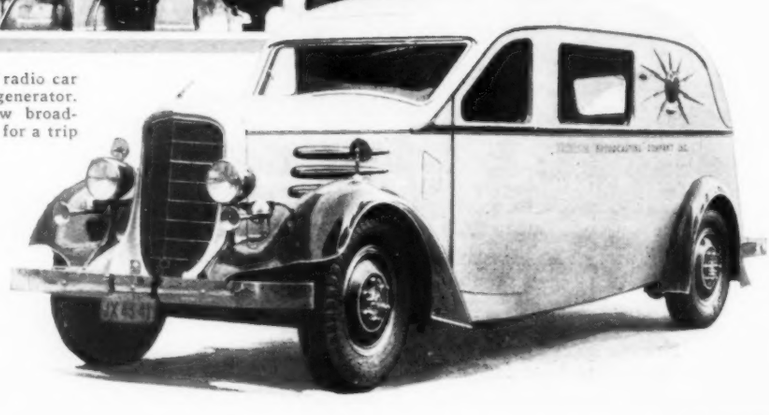
Three methods of broadcasting are provided. When the car is in motion, an ultra-short-wave transmitter is employed, using a tiny antenna on the roof of the car. The program is picked up at any convenient point within a fifty-mile radius and carried by land line to the regular studio, where it is rebroadcast. For ultra-short waves, a high point of reception is required, and the tower of the Empire State Building will be used in the New York City area.

Once the car has reached a destination, a different transmitter, operating on a longer wave length, is placed in service. A reel antenna is strung up on jointed masts of bamboo. This transmitter has a 100-mile range.

When the car cannot be brought to the scene of an event one of the crew goes out on foot, carrying an ultra-short-wave transmitter on his back. This pack transmitter has a five-mile range, and the radio car itself rebroadcasts the program to the pick-up station as previously described.

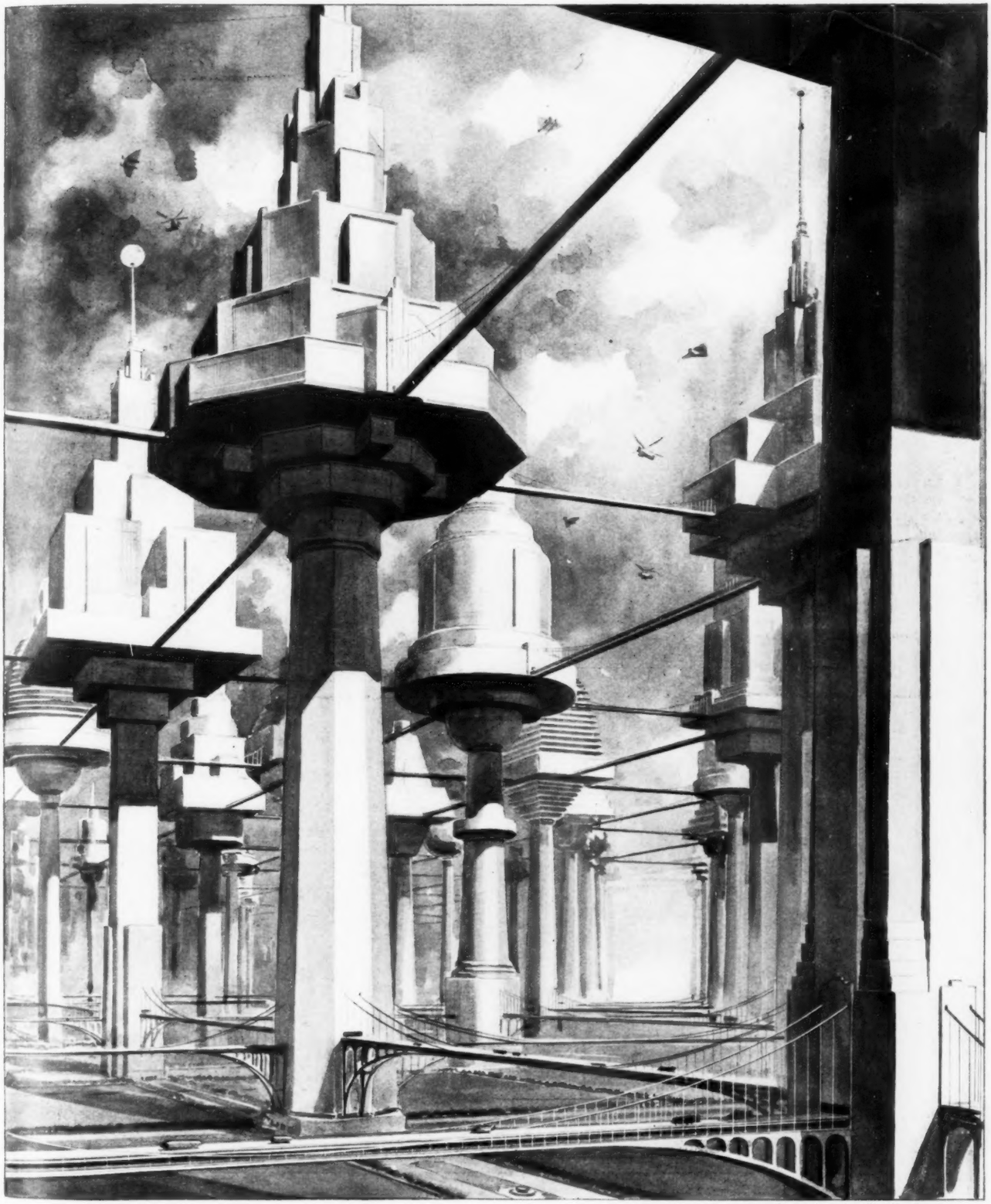
Fittings of the broadcasting car are amazingly compact for their efficiency. The front of the machine is set off as a soundproof studio and is separated from the rear by a thick glass window. Standing on the front seat, an announcer may thrust his head and shoulders through a trapdoor in the car roof to obtain a better view. The two transmitters and their control panels are housed in the rear of the car, together with a gasoline-driven generator that supplies the power to operate them.





Above, interior of radio car showing motor generator. At right, the new broadcast car all ready for a trip

City of Treelike Buildings Planned

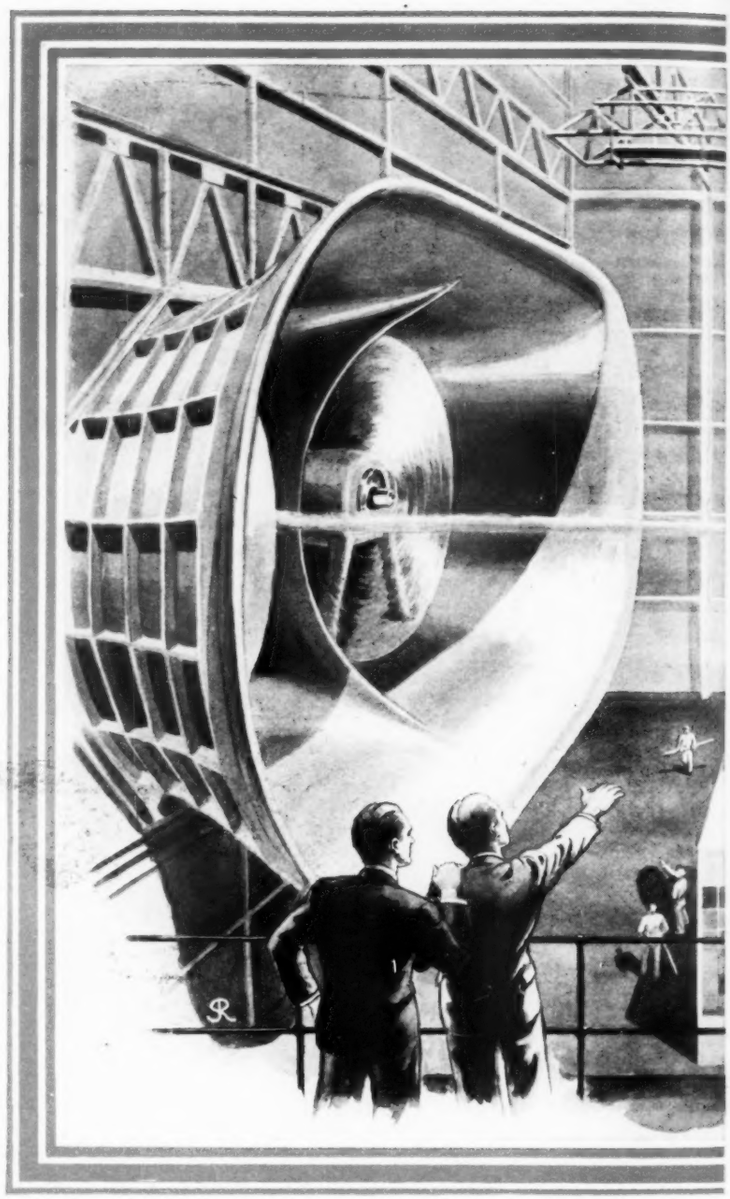


Drawing by B. G. SEIELSTAD

SHAPED like trees with slender trunks, homes and office buildings of the future may rise into pure air on pedestals of steel. Our artist presents here his conception of this startling proposal, made recently by R. H. Wilenski, noted British architect. The scheme leaves the ground level virtually unobstructed. Each building is supported upon a single, stalk-like shaft of steel or strong, light alloys, resting in turn upon a massive subterranean foundation. Modern advances in the design of high-speed elevators simplify the problems of transporting passengers between the buildings and the earth. Access from one building to another is provided by a system of suspension bridges, and stores and places of recreation contained in the building make it possible to dwell aloft for an indefinite time without needing to descend. Gigantic, luminous globes are placed at strategic points to light the aerial city by night, while by day the inhabitants enjoy the unfiltered sunshine and fresh air of their lofty nests.

FASTER, SAFER PLANES DEVELOPED IN

Biggest Wind Tunnel

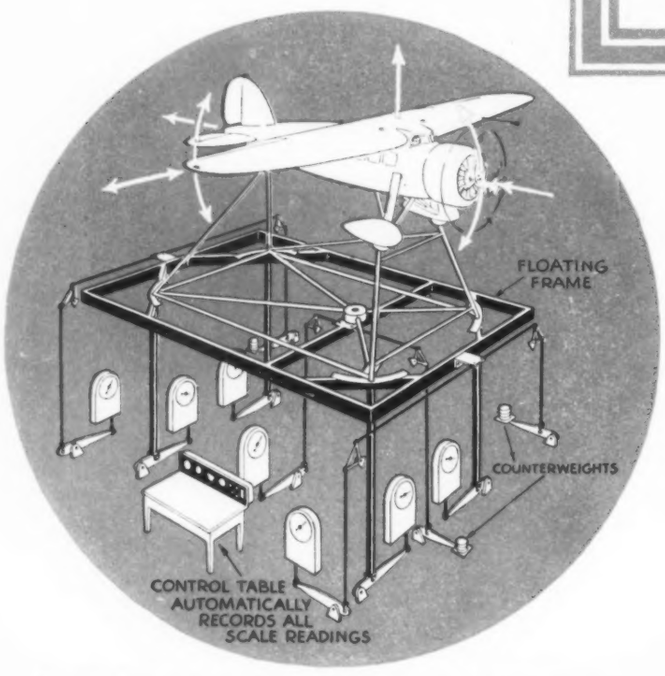


SPEED with safety in the air. Speed with economy of operation. Speed with comfort for air travelers. For the past few years these speed demands have been insistently made by the users of airplanes and especially by the airline companies whose existence depends on the swift, safe, dependable, and economical transportation of passengers, mail, and express.

The builders of commercial airplanes are meeting this demand so successfully that the operating chief of an important air-transport line tells me that his ships never wear out—that they are replaced by faster planes while they are still in excellent shape.

A year ago there wasn't a multi-motored transport plane manufactured that had a rated speed of more than 150 miles an hour.

Today the Douglas DC1 Airliner, carrying a pay load of twelve passengers and more than 1,000 pounds of cargo, has a top speed of 240 miles an hour, and an economical cruising speed in excess of 200 miles an hour. The Boeing 247 Transport, carrying a pay load of 2,400 pounds, has a cruising speed of 171 miles an hour. The new Curtiss Condor biplanes, that soon will go into service, have a high speed of 170 miles an hour, and a cruising speed of about 150 miles when carrying 3,200 pounds of revenue-producing load. The Martin B-10 monoplane, an adaption to commercial use of the Martin military ship, is another of the superfast transport planes now on the market. The Martin military plane, which can do 200 miles an hour while carrying a ton of bombs, won for its creators, in 1932, the Collier Trophy awarded to the year's outstanding achievement in aviation.



Cut-away view of room containing instruments that automatically record lift, drag, and force of cross winds as artificial gale buffets plane. Position of the recording dials is clearly shown in the illustration

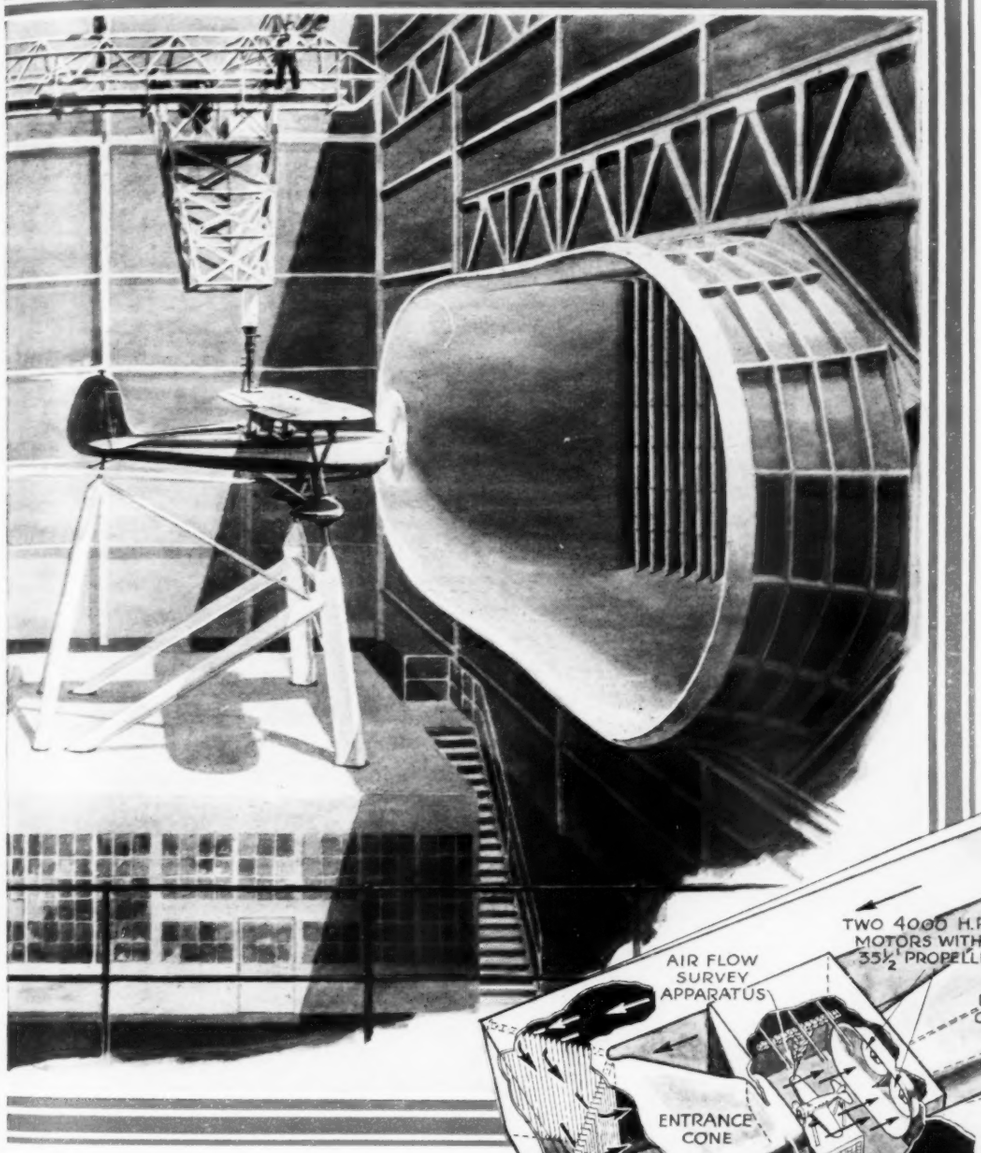
In developing today's high-speed commercial planes the manufacturers have not built ships with bigger engines to be operated at higher costs. Nor have they sacrificed airworthiness or comfort. They have achieved increased speed by turning out planes of improved design and increased aerodynamic efficiency. In doing that they have followed the trail blazed by the air scientists who work patiently for the advancement of aviation in the marvelously equipped Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics.

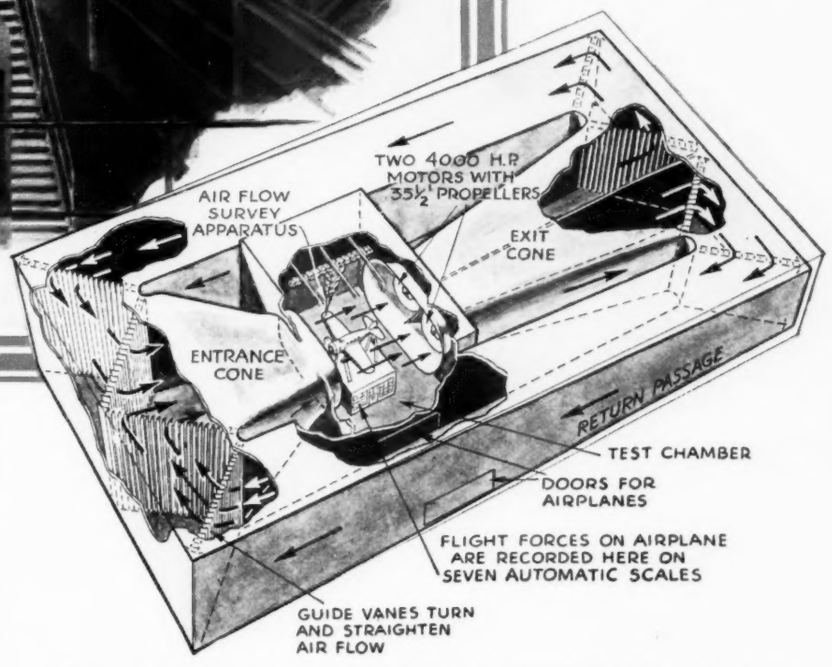
The N. A. C. A. has its executive offices in the Navy Building in Washington, and its laboratories, workshops, and hangar on the Army Air Corps post at Langley Field, near Norfolk, Va. It is, however, an independent government organization. Its fifteen members are appointed by the President of the United States and serve without pay. The job

Aircraft That Can Speed at Six Miles a Minute is Goal of Great Flight Laboratory

By
Arthur Grahame

Drawings by
STEWART ROUSE




TWO 4000 H.P. MOTORS WITH 35½ PROPELLERS
AIR FLOW SURVEY APPARATUS
EXIT CONE
ENTRANCE CONE
RETURN PASSAGE
TEST CHAMBER
DOORS FOR AIRPLANES
FLIGHT FORCES ON AIRPLANE ARE RECORDED HERE ON SEVEN AUTOMATIC SCALES
GUIDE VANES TURN AND STRAIGHTEN AIR FLOW

At top of page, the home of the world's biggest wind tunnel. A full-size plane is tested in the path of a gale that sweeps out of the tunnel at 118 miles an hour and is carried away by the opening at left. Above, cut-away view of tunnel showing course of the air

of its technical force, headed by Dr. George W. Lewis, director of aeronautical research, is the scientific study of the problems of flight for the benefit of all American aviation —commercial aviation quite as much as military aviation.

Because aircraft operate in the air, N. A. C. A. flight-science pioneers realized, when they started their work nineteen years ago, that one of the first things they would have to learn was how to control, surely and accurately for experimental purposes, the most elusive of the elements.

Of course, much could be learned from actual flight. Ingenious and highly accurate instruments were developed to measure and record speeds, pressures, and the positions of control surfaces while an airplane is flying. But flight tests could not solve all the problems of aviation. So a five-foot wind tunnel was built at Langley Field. In it small-scale airplane models, or full-size small parts of planes, could be mounted on delicate scales and balances, subjected to a blast of air that simulated the conditions of actual flight, and pressures and strains measured.

Later on, other and much-improved wind tunnels were built. There are a dozen of them now. A vertical tunnel is used to study the spinning characteristics of small-scale models of various types of planes. There is a steel-tank-enclosed, variable-density tunnel in which models are tested in air that is compressed in inverse proportion to the model's scale. For example, a one-twentieth-size model is tested under twenty times normal air pressure. Means for studying and preventing the formation of ice on airplanes are studied in a refrigerated tunnel. A twenty-foot tunnel, with an air speed of 110 miles per hour, is used for the full-scale testing of propellers, and also of the other parts of the plane, including fuselage, engine, landing gear, and tail surfaces.

Newest, and most impressive, is the full-scale tunnel, the world's largest, in which may be studied and measured accurately the flying characteristics of a complete full-size airplane, and in which engine and cowling problems may be investigated under conditions similar to those of actual flight.

At first glance the big structure that houses this gigantic

apparatus looks as if it was built inside out, for the structural steel frame is *outside* the cement-asbestos sheets that form its walls. Of course, there has been no mistake. This building, 434 feet long and 222 feet wide, was designed to withstand wind blasts of hurricane force rushing through the inside of it.

Standing in the lofty test chamber of this house of the winds, I saw, far above my head, the mouth of a smoothly planked elliptic cone sixty feet wide and thirty feet high. Directly opposite it, and fifty-six feet away, is a similar cone, split by a smooth fairing into two circular passages. In each of these passages is mounted a four-blade, cast-aluminum-alloy propeller thirty-five feet, five inches in diameter driven by a 4,000-horsepower electric motor.

Beyond the propellers the circular passages gradually change their shape and grow larger, until at the end of the building they are forty-six feet square. At their ends series of wind vanes, that look like airplane wings set on end, are adjusted carefully to turn the airstreams smoothly into the fifty-foot-wide return passages that run the length of the building. At the other end more vanes turn the airstreams again, so that they join in the 110 by 72-foot entrance cone that narrows gradually to sixty by thirty feet at its mouth.

In the big test chamber, between and beneath the gaping mouths of the wind cones, stands a glassed-in control room, its roof about level with the lower lips of the cones. Struts, protected by streamlined fairings attached to the roof, protrude from the roof of the control room. On them is placed a plane ready for testing in the artificial hurricane.

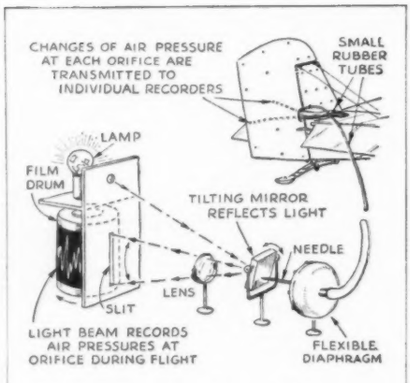
Inside the control room, protected from wind currents, is the balance that measures the air forces to which the plane under test was subjected—a balance large enough to weigh a big airplane, and yet delicate enough to serve as a postal scale.

The struts on which the axles of the plane were mounted, and the triangular frame to which its tail was attached, are secured, inside the control room, to a turntable attached to a floating frame resting on struts that transmit the lift forces to four scales. A linkage attached to the floating frame, and acting against a counterweight, transmit the drag forces to another scale. Two other linkages, attached to the frame at its front and back, and also working against counterweights, transmit the cross-wind forces to two other scales. The turntable allows the airplane to be yawed from twenty degrees left to twenty degrees right, and the frame on which the plane's tail rests can be raised or lowered, altering the wings' angle to the airstream.

With everything ready for a test, the flight scientist in charge pushed a controller handle. The big propellers began to purr. A brisk breeze leaped across the test chamber. He pushed the handle over another notch. The wind began to howl and soon reached full gale force. The dials of the seven scales were registering its pressure on the plane. The operator pushed a button, and the reading of each scale was recorded. He pushed the controller handle over another notch, and then another and another, until a mighty blast was roaring across the test chamber at the hurricane speed of 118 miles an hour.

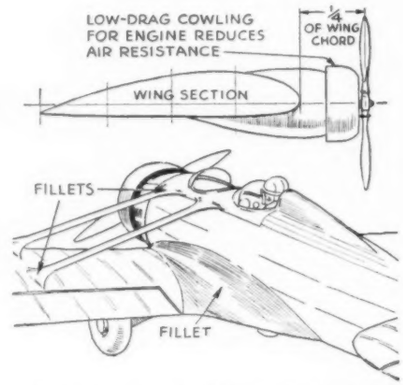
Inside the control room the air forces acting on the stationary plane from three directions, much as they would in high-speed flight, were being registered by the dials of the scales, which also recorded the intensity of the rolling, pitching, and yawing tendencies about the plane's three axes. Outside, stationed in a car mounted on a movable bridge above the path of the man-made hurricane, another engineer was intent on measuring, with a delicate instrument suspended from the car, the air flow around the plane. Much of value has been learned through this method of studying the downwash behind the wings and the air flow around the tail surfaces of planes.

Not all of the *(Continued on page 110)*



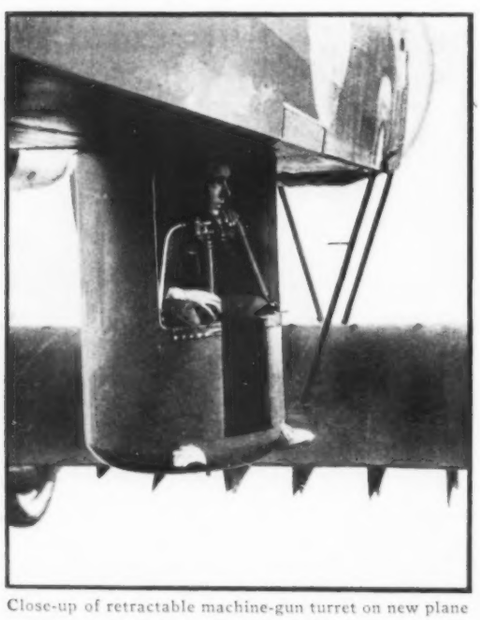
Measuring Air Pressure in Flight

Diagram shows how an automatic record is made of changing air pressure at various points on exterior of a plane during a flight. Note tiny orifices in rudder that admit air which affects flexible diaphragm



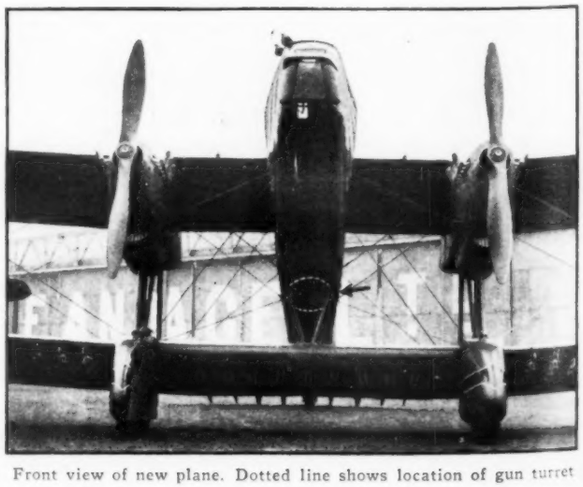
How speed of modern aircraft has been increased by cowling, fillets, and proper placing of propeller with regard to the wing is made clear in this diagram. Use of fillets has raised speed twenty miles an hour

New War Plane Has Movable Gun Turret



Close-up of retractable machine-gun turret on new plane

OFFICIALLY known as an express bomber, England's latest 150-mile-an-hour war plane has been nicknamed the "flying ash can." It takes its name from the cylindrical turret that can be dropped below the fuselage during flight. Protected within the turret, a machine gunner can pour a deadly stream of fire upon hostile aircraft attacking from the rear. When no longer needed, the turret is pulled back into the fuselage to reduce wind resistance. The big bomber is powered with two 525-horsepower motors, and has a cruising range of nearly 1,000 miles without refueling. Despite its ponderous appearance, it can rise to an altitude of nearly two miles above the earth, affording an important advantage in wartime maneuvering.



Front view of new plane. Dotted line shows location of gun turret

Camera Makes Lifelike Statue

454 Pictures Strung Together in New Sculpture Process

ULTRA-SPEED CAMERA MAKES 454 PICTURES OF LIGHT TRACE ON FEATURES OF SITTER
STREAK OF LIGHT OUTLINES PROFILE OF SUBJECT
LANTERN PROJECTS BEAM THROUGH NARROW SLIT TO PRODUCE STREAK OF LIGHT ON SUBJECT
TURNTABLE MAKES ONE TURN IN 4 SECONDS

1 A streak of light, thrown on the sitter, outlines his features so camera can record them for reconstruction

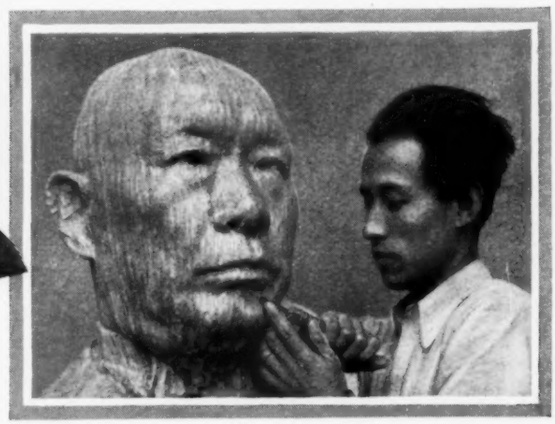
PROFILE PLATES ARE ASSEMBLED ON WIRE RING USING WASHERS FOR SPACING
SPACE BETWEEN PLATES IS FILLED IN WITH PARAFFIN WAX
EACH PLATE CORRESPONDS TO ONE OF THE 454 PROFILE PHOTOGRAPHS

2 Here is the record made by camera. Each line represents sitter's profile seen from a different angle

3 Enlarged and pasted to a thin metal strip, the film is then cut apart with a jig saw

4 The sawed-out metal strips are assembled on a wire ring and cracks are filled with melted paraffin

6 Bust of Col. Charles A. Lindbergh made by the new process. It is striking evidence of the fidelity to life in this sculpture



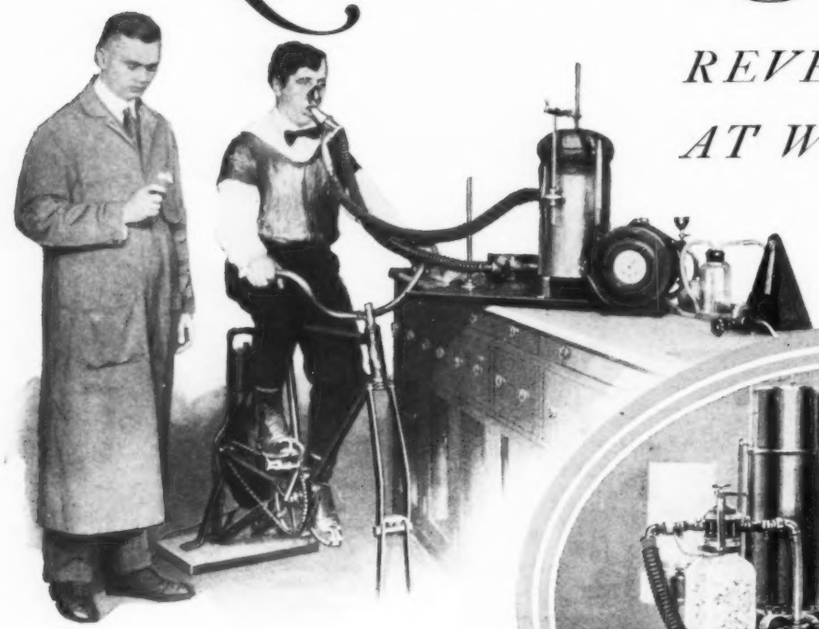
5 The resulting model then goes to a studio where it is retouched by a skilled artist, just as a photograph is retouched. This operation is illustrated in the picture seen below

VISITING the sculptor is as simple as going to the photographer, and nearly as inexpensive, with the invention of a process known as "sculptography." Already in use in Japan and soon to be introduced in this country, it produces a bust or statuette of startling realism by almost purely mechanical means. All the sitter need do is pose for exactly four seconds while a camera analyzes his features—and then call for the finished sculpture. When the subject comes to the studio, he is seated in a chair on a turntable and a projector is adjusted so that it casts a narrow, vertical streak of light across his features. The turntable is then set revolving, and a high-speed motion picture camera, set at a thirty-degree angle from the projector, makes a continuous record of the glowing outline of the sitter's profile during one complete revolution. An especially ground lens corrects the foreshortening of the contour from this oblique point of vantage, and gives it the same effect as a photograph made at right angles. The result is a one-yard strip of film bearing pictures of 454 separate light traces, from which the subject's features can be reconstructed.

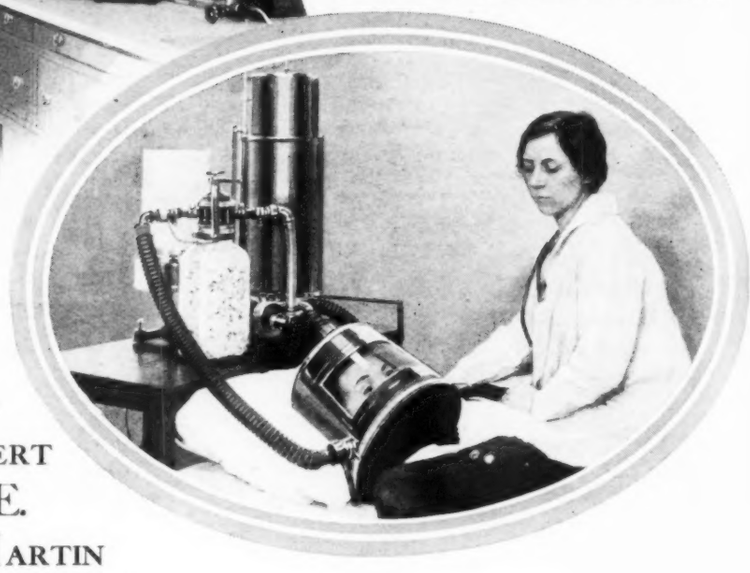
To do this, the picture strip is first enlarged to the desired size; a photographic enlargement a foot and a half wide and twenty feet long is used for a life-sized bust. The print is pasted on a thin metal sheet, and deft hands guide it beneath a jig saw, carefully cutting out the outline of each profile. At the end of this task the operator has a pile of 454 curiously shaped metal plates, each one representing the sitter's profile from a certain angle. When the plates are now assembled in their proper order on a wire ring, the first crude likeness of the subject appears. Paraffin is then poured over the model to fill in the spaces between the plates and to smooth off the surface. So far no artistic ability has been required, although a good likeness of the subject has been obtained. As a last step, the figure is retouched, just as a photograph is retouched. Then a plaster or gypsum mold of the figure is taken, and from this bronze copies may be made. The finished work is said to be as good as that done by an artist.

New Energy Tests

REVEAL OUR LOSS AT WORK OR PLAY



Respiration apparatus used in measuring the oxygen consumed by a bicycle rider. The man's nose is closed with a clip and he breathes through the rubber mouthpiece. With oxygen consumption known, the energy expended can thus be accurately computed



Some energy is consumed in merely keeping alive. In test, below, the comfortable subject breathes through the tube connected to his helmet so the oxygen used can be measured

By ROBERT E. MARTIN

ALL the hearts beating in the United States develop about 70,000 horsepower!

Half a peanut furnishes sufficient energy for an hour of intense mental effort!

Eighteen holes of golf consume as much energy as climbing five times to the top of the Empire State Building, the world's highest skyscraper!

Such are the surprising facts discovered by experts in the field of experimental physiology. In their study of energy and fatigue they are collecting curious information about our bodies, about how hard we work for a living, about the relationship that must exist between energy and disease.

Using improved methods and newly devised apparatus, scientists under the direction of Dr. Francis G. Benedict have just completed the latest energy tests at the Carnegie Institution of Washington, D. C. Men peddling bicycles without wheels, girls typing at top speed in enclosed cases, subjects living for days in glass houses, helped them assemble data on the energy we use to keep alive and to perform the various tasks of everyday life that constantly drain our energy.

When we wake up in the morning, they found, if we lie quietly in bed our bodies actually consume less energy than a seventy-watt electric light bulb! But if you sit up, the consumption jumps five percent. Stand up and it jumps ten percent. Walk briskly across the room and it leaps 200 percent. Run as fast as you can and it zooms 1,000 percent. When you lie quiet, two lumps of sugar will run your body machine an hour, a pat of butter an hour and a half, a doughnut will furnish fuel for three hours.

The average laborer, other tests show, has to work eight hours a day every day in the year to turn out the equivalent of 242 kilowatt hours of electrical energy. That is just enough to keep the Lindbergh Beacon at Chicago burning for approximately half a day. In other words, it would require the energy of 543 men working eight hours a day to keep burning this biggest aerial searchlight in America.

One curious discovery made by Dr. Benedict was in connection with mental effort. His experiments showed that a housekeeper dusting out the study of an Einstein or an Edison would consume more energy in three minutes than the profound thinker would use in an hour of concentration!

Then why does brain work make us tired?

Six men and two women took part in the experiments which sought the answer. Each underwent tests while in three different mental states: awake but thinking of nothing in particular, following a definite train of thought, and concentrating intently. Mental effort, it was shown, slightly increases the pulse rate, the depth of breathing, and the oxygen consumption of the body.

But the added energy used is so slight that a piece of banana no larger than the end of your little finger will support steady concentration for nearly an hour. In fact, the increased consumption of energy is so trifling it fails to explain the mystery of the bodily exhaustion which follows prolonged brain work. The only answer science can make at present is that the strain of the eye muscles in reading, the ear muscles in hearing, and the body muscles in maintaining the same position produce the fatigue.

Every year, the average pair of lungs expand and contract ten million times; the average eye roves back and forth thirty-six million times; the average heart beats forty million times, pumping enough fluid through our veins to fill fifty average railroad tank cars. All this activity goes on without conscious effort. The energy expended in keeping the human engine running while it is thus out of gear is known as its basal metabolism. Metabolism means the process by which our bodies turn food into energy and tissue.

After the experts have determined the level of energy consumption required to keep the body alive, they can easily measure the added energy consumed in a given task. There are three ways of doing this: One is by the amount of oxygen taken in; another by the amount of carbon-dioxide given off, and a third by the amount of heat liberated by the body.

All three occur in such a constant ratio

HARDWORKING CHORUS GIRL

According to the oxygen consumption test, this dancer works harder at her job than a ditch-digger, or a housewife

that any one check will give the information sought. Usually the oxygen consumption or carbon-dioxide production is used, the subject breathing through special tubes which lead from and back into rubber bags.

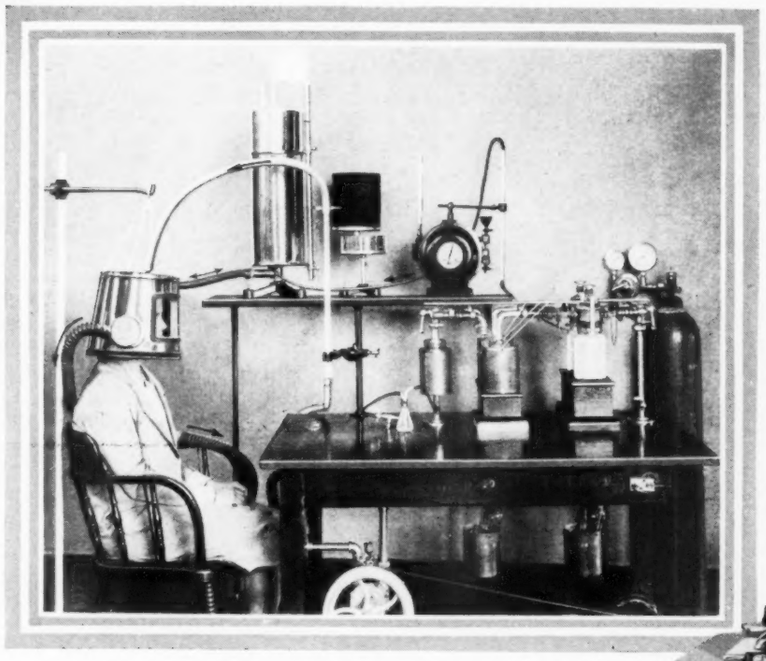
Using such methods, Dr. Carl Tigerstedt, of the University of Helsingfors, Finland, not long ago, discovered some surprising things about the energy consumed in dancing. The Charleston, popular a few years ago, used up approximately as much energy as sawing wood. The Polish Mazurka consumed almost as much as wrestling. Even the waltz results in a person of normal weight expending bodily heat sufficient to raise the temperature of five pints of water from the freezing to the boiling point.

On the list of energy-consuming tasks around the house, he found washing heads the list. Sweeping comes second with ironing about half as hard as washing. Dressing the baby proved to be seven times as tiring as sewing by hand, and the general work done by the average housewife was shown to be as hard as that done by a carpenter or housepainter.

Climbing stairs is just fifteen times as difficult as walking on a level floor. Incidentally, the most efficient way to climb stairs, the way that puts the least strain on the body, is at the rate of about a second a step. By saying "one hundred and one" between each step, the pace can be gaged easily.

During one of their experiments, Dr. Benedict and his co-workers built an airtight, heat-tight chamber in which a person could live for days under controlled conditions. Ingenious devices enabled the observers outside the glass house to measure the heat produced by the subject when he was asleep, resting quietly, physically active, eating, fasting, and concentrating on mathematical problems. One discovery was that a heavy meal will increase the heat output of the body as much as forty percent and cause it to remain above normal for as long as twelve hours.

Because the body burns food and liberates heat in producing energy, the unit used in measuring energy is the calorie. It represents the amount of heat required to raise the temperature of about a pound of water four degrees Fahrenheit. Foods are also measured in calories to designate their energy producing value.



Wearing an airtight helmet so her energy consumption can be gaged, this girl is solving a problem in mental arithmetic. She uses little energy. Arrows indicate flow of oxygen in tubes

If we lie in bed all day, 1,700 calories of food will keep our bodily machinery functioning. If we work at a desk, we need 2,500 calories. If we pitch hay on a farm, we need 3,500. A Maine lumberman may consume 7,000 calories; a six-day bicyclist 10,000. The average man eats more than five pounds of food a day, about a ton a year. Thus, in less than a month, a 150-pound man eats his own weight in food.

Astonishing chemical engines within the body carry on the work of transforming this food-fuel into energy. Every muscle is a powerhouse in miniature. It takes sugar brought by the blood and changes it into glycogen, a white, starch-like powder, which it stores up for future use. Glycogen, according to the famous English scientist, Dr. A. V. Hill, who was awarded the Nobel Prize for his researches, is one of the most potent chemicals known. It represents a concentrated form of energy nearly four times as powerful as dynamite! One gram, three and a half hundredths of an ounce, contains enough potential energy to lift a ton of rock six feet into the air!

When you turn a page of this magazine, glycogen enables you to do it. Each of the hundreds of thousands of fibers in your biceps is charged with this animal starch. When the command races down from the brain along the nerve lines, each cell of which passes on the message in less than a hundred thousandth of a second, an instantaneous chemical reaction takes place. The glycogen, as though it were gunpowder touched off by a fuse, changes and becomes lactic acid, the chemical found in sour milk. This acid causes the muscle fibers to contract in unison, thus lifting your arm.

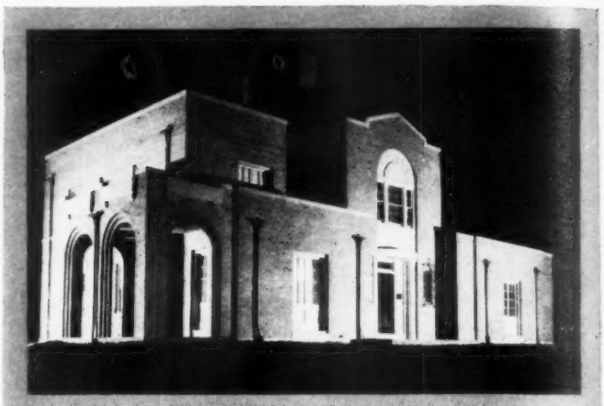
Immediately afterwards, oxygen, carried along the fibers by blood capillaries, reconverts as much as three fourths of the lactic acid into glycogen and burns up the rest by oxidation. In this way, the muscles are prepared for the next contraction. It has been found that five gallons of blood are required to carry one gallon of oxygen.

Dr. A. V. Hill has found that for every gram of lactic acid developed during exercise, 370 calories of heat are produced. When the *(Continued on page 116)*

With her nostrils tightly closed, this girl is breathing oxygen through the tubes while ironing, which is fairly easy work

• First Fully Electrified

Approaching the door, left, the housewife's foot depresses a movable board and the door opens before her so she can go from kitchen to dining room with both hands full. Right, exterior view of the new home of tomorrow



Moving a lever, set between the windows, the housewife, right, starts an electric ventilating fan over the central lamp. Note curved ceiling to reflect the light

CALLED the world's most completely electrified dwelling, a six-room house just completed at Mansfield, Ohio, will serve Westinghouse engineers as a laboratory in planning the home of tomorrow. Three and a quarter miles of wire operate its 320 electric light bulbs, eighty-seven convenience outlets, and twenty-one built-in appliances, many of which are types never before installed in a residence. Simply by pressing a button and speaking into a wall microphone, a housewife converses with front-door callers from any part of the house. An electric wagon brings dinner to the table; when its reeled cord is plugged in an outlet, hot and cold compartments keep food at the right temperature throughout the meal. The door to the kitchen, responding to her weight on a foot treadle, opens as by magic when the housewife approaches it, hands full of dishes. A concealed motor whisks the elevator-type panels into the wall. Dishes wash themselves and towels are dried electrically in the kitchen. Should the housewife scratch her finger on a pin, an electric cell in the laundry manufactures fresh chemical antiseptic. A weather factory in the basement warms the house in winter and cools it in summer, while a top-floor pent house has its own heating plant consisting of electric wires embedded in the walls. An electric sentinel in the two-car garage guards the owner from asphyxiation by exhaust fumes; if he starts the car's motor with the doors closed, they open automatically. The doors may also be operated by radio from the car's dashboard. Engineers maintain that the all-electric home is in no sense a stunt dwelling, but a practical working model of the home of the future. Its estimated monthly electric bill of thirty-seven dollars is called not excessive in view of the work done.

Electric units in this serving table keep food either hot or cold. It will hold food for an entire meal. At far right, living room with indirect lighting. Note weather units near ceiling

House Runs Itself

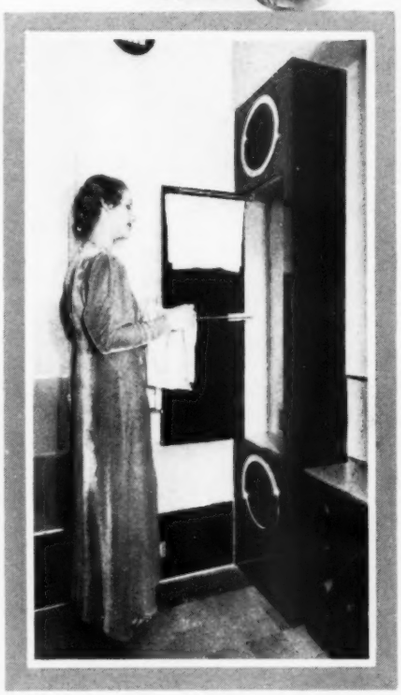
The serving pantry is provided with electrical apparatus which enables the housewife to prepare a light supper without using the equipment in the kitchen

Dirty dishes are placed in this electric washer and the lid closed. Throwing a switch washes and dries dishes

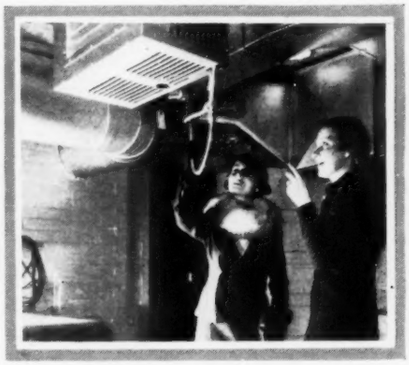
Three tubs, with a centrifugal dryer in the center, constitute the clothes-washing unit which speeds this arduous task with little work on the part of the housewife. The only unit of its kind in existence

Below, illuminated mirror in the main entry hall. Note panel lights on each side and across the top

Facilities for hand ironing are provided in the laundry. On the shelf behind the woman is a radio set, a telephone, and the handy electric doorman



In the main bathroom is a towel dryer. At the bottom of the dryer is an electric heater and a fan that blows hot air past the towels. In the laundry is the big drying plant as seen at left. Moist air automatically turns on heater



In the basement of the electrified house is the weather-making apparatus. One of its features is the "reversed refrigeration" by means of which water is heated. The woman in picture is pointing to the heat pick-up of this refrigeration unit

Live Adventures *with*

TAXIDERMISTS HAVE THRILLING

Three black bears, effectively mounted in lifelike poses for a museum, are carefully arranged against an appropriate background in a realistic habitat

Below, a mounted dik-dik. This is an African antelope, slightly larger than a rabbit

By THOMAS M. JOHNSON

NOAH WEBSTER said in his dictionary, that taxidermy is "the art of stuffing animals." It is much more than that now, and "stuffy" it never was. At any moment in the taxidermist's life, in may rush adventure or bizarre experience. Nor is this surprising, since taxidermy deals with all manner of creatures, frequently wild, which are sometimes alive when they seem to be dead, and sometimes dead when they seem to be alive. As a few true stories will illustrate.

Not long ago someone sent a rattlesnake to a New York taxidermist to be mounted. Dangerous, but this taxidermist knows the tricks. Carefully, he pried off outer boards from the stout express box. He wore big, thick gloves. The snake, a handsome diamond-back, was powerless, imprisoned by the venom-spotted glass. Slowly, cautiously, the taxidermist raised part of it. Like a flash, the snake darted through into a big, strong glass jar, whose heavy top the taxidermist clapped down. For an instant, the angry snake thrashed about. Then, the coils relaxed, the head dropped, paralyzed by the two ounces of chloroform the jar contained.

Donning rubber gloves, the taxidermist took out the limp body. He placed it on the workbench, arranged it in various poses, seeking the one in which it would look best when mounted. That found, he poured around the black and yellow coils, white plaster of Paris, as the first step toward a wax replica. Then, to hasten drying, he turned the mass over. This left the insensible snake's belly uncovered, but the taxidermist knew that long before the chloroform wore off, the plaster would be dry, the snake back in the box.

The telephone bell rang and the taxidermist answered it. A few moments later he returned to the workbench. The mold was on the floor, smashed into a thousand pieces. The chloroform had worn off; the snake's writhings had dashed itself and the mold to the floor of the workroom.

A tiny rustling sound, a rattle, behind him! He whirled, but too late. The rattlesnake struck. Luckily help was at hand. The taxidermist was saved and the snake captured after a perilous hunt through the studio.

That near tragedy contrasts with what happened recently to the three Jonas brothers, who are among this country's leading taxidermists. At their large studio in Yonkers, N. Y., they had mounted three black bears, for a museum. All were in lifelike poses, eyes twinkling, coats glossy. Next they must be arranged effectively, and an appropriate background reproduced, for a natural-looking habitat group.

Near the studio is a patch of semi-woodland; the very spot for a dress rehearsal. There the Jonas brothers took their three black bears, trying them first one way, then another. Just as they got them right, they heard a wailing siren. A police car stopped at the roadside.

"Stop abusing those bears," the officer commanded.

"Abusing?" chorused the three Jonas brothers. "Why, the bears are dead—and mounted. See?" They demonstrated. "We're taxidermists."

"Taxidermists, eh?" the policeman repeated. "A woman telephoned you were abusing three helpless black bears."

One taxidermist received, without explanation, a box labelled HAWK—DEAD. He bent down, peeped through a slit in the side of the box. Suddenly, from it darted forth a long, snakelike neck, tipped by a sharp bill. It dealt the taxidermist a blow that sent him sprawling, blood pouring from a cut

MOLDS READY FOR INSTANT USE

To speed his work, the modern taxidermist keeps on hand molds of animal heads and bodies of various sizes and shapes

Specimens of Solenodon paradoxus, opossumlike animals, mounted for American Museum of Natural History

Dead Animals

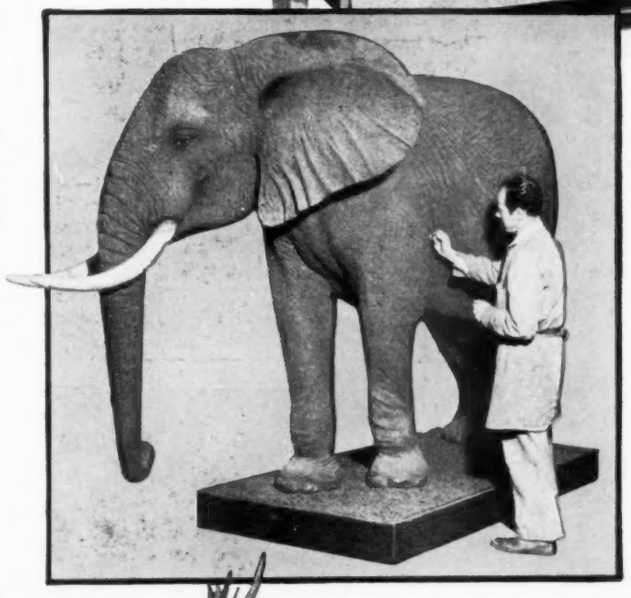
TIME PRODUCING MOUNTED SPECIMENS

between the eyes. The "hawk-dead" was a very lively bittern, whose neck and bill are a formidable weapon.

Modern taxidermy, as practiced by its leading exponents, especially for the great museums striving to preserve a record of all the wild animals as they live on their native heath, reaches out very far. It sends into Africa, Asia, South America expeditions of hunters, naturalists, artists, taxidermists; perhaps men who are all four, like the late Carl Akeley, James L. Clark, or John Jonas. They not only shoot animals and bring home their skins and bones, but they also bring the results of a study of those animals at first hand, sketches and photographs of their most appealing postures, of typical and beautiful aspects of their natural surroundings. These are embodied in habitat groups, scientifically accurate, yet artistically pleasing to the eye. Science alone would give accuracy without interest; art alone, interest without accuracy. Taxidermy secures both.

So a taxidermist, returning from *safari*, will bring collections of stumps and branches of trees, bits of moss, rocks, grasses, brushes, ferns, even small birds and insects, all to be fitted somehow into a group showing the actual surroundings in real life of the animal specimens. Some things can be dried and used as they are, but green leaves, flowers and fleshy plants must be reproduced in wax, glass, celluloid, or other suitable materials, while rocks generally are made of plaster matching the sample in color and texture. When an animal is shot, each item of information that will assist in reconstruction in the museum is carefully recorded —such as some seventy tape measurements of a tiger. For the completed group there must be, if possible, not single animals, but groups showing an old male and female, a young male and female, and young, to complete the picture.

Below, left, an excelsior-stuffed form which was used in old-fashioned taxidermy. Right of it, modern molded form



This elephant is made entirely of paper, with the exception of the eyes which are glass, and eyelashes which are hair

Below, adjusting the strings to hold the ears at exactly the correct angle to give a lifelike appearance to mounted specimen

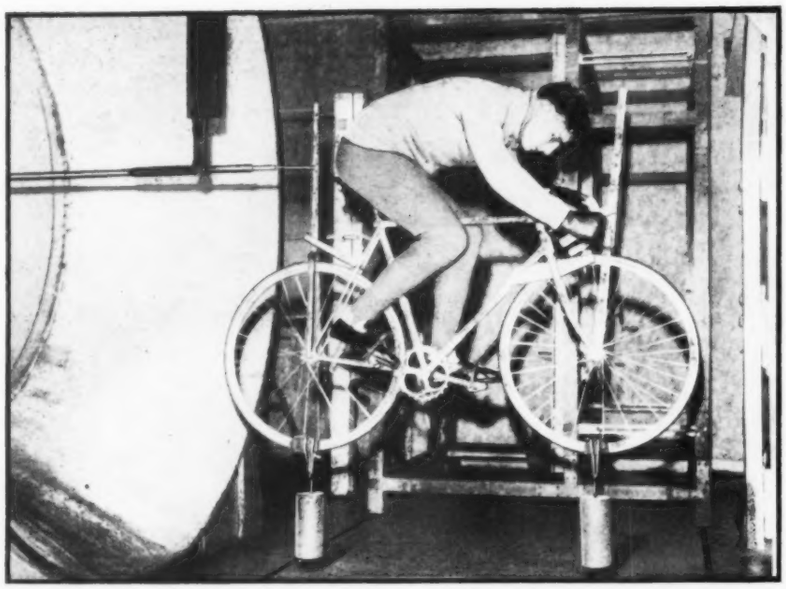
To get them, these versatile taxidermists run desperate risks. Clark, now assistant director of the American Museum of Natural History in charge of preparation, has shot at close range lions, grizzly bears, ibex, and other wild animals. At fifteen yards he killed a charging rhinoceros Radclyffe Dugmore had just photographed. Perched in an acacia tree, he watched scores of angry elephants stampeding beneath, searching for him. John Jonas has traveled 8,500 miles on *safari*, and had many adventures. Once he shot a charging rogue elephant.

The revolution in taxidermy that made these efforts and risks worthwhile, began with the daring, artistic, and scientific Akeley. Once animals were mounted by placing the skin over a framework, turning it upside down, and stuffing it with hay or excelsior. Then the animals were modeled in plaster of Paris, and the skin stretched over the dummy. That prevented much correction of mistakes.

Akeley began modeling animals in clay. Then covered the mold with plaster of Paris in two sections, removed them from the clay model, and lined them with papier-mache and wire netting, making a shell about an eighth of an inch thick. This shell, when removed from the two molds and placed together, reproduced the clay model in a light and permanent form. To this form, the tanned skin was applied. Later Clark introduced, and Akeley adopted, wooden ribs within the papier-mache form. The papier-mache models, hollow, *(Continued on page 112)*

CYCLIST USES WIND TUNNEL IN TRAINING

IN ORDER to study the wind resistance experienced in various postures, a French racing cyclist has availed himself of an aeronautical wind tunnel for tests. Mounting his machine, which is suspended at the mouth of the wind tunnel, the rider attempts to counteract its force by changing his position. Thus he trains himself to adopt a style that will cause the least fatigue at various speeds in actual competition.



Racing cyclist uses a big wind tunnel in perfecting his speed technique

FLOWERS FROZEN IN ICE

FROZEN solid in blocks of ice, fresh blooms of the Australian wattle and bottle brush were recently shipped successfully to London, England, to be displayed at a flower show. The conical blocks were polished as shown above to give visitors a clear view of the contents.

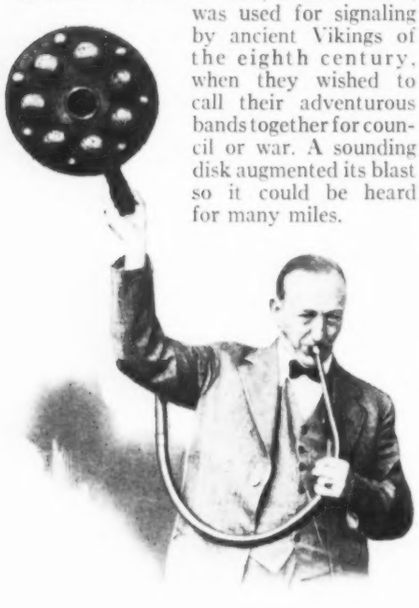
NINE GOLF CLUBS ARE COMBINED IN ONE

INVENTED by a Chicago jeweler, a new adjustable golf club combines nine different types of irons in one, reducing the assortment needed for a golfer's bag and consequently the weight that must be carried by the caddy. Numbers on the swivel head of the club and its mounting indicate the angle of setting for each type of stroke. Thus, when the two 5's are aligned and a simple locking device has been applied, the club is ready for use as a mashie. A telescoping handle permits the club to be adjusted to any length suitable to the player's height.

Nine golf clubs are combined in this one

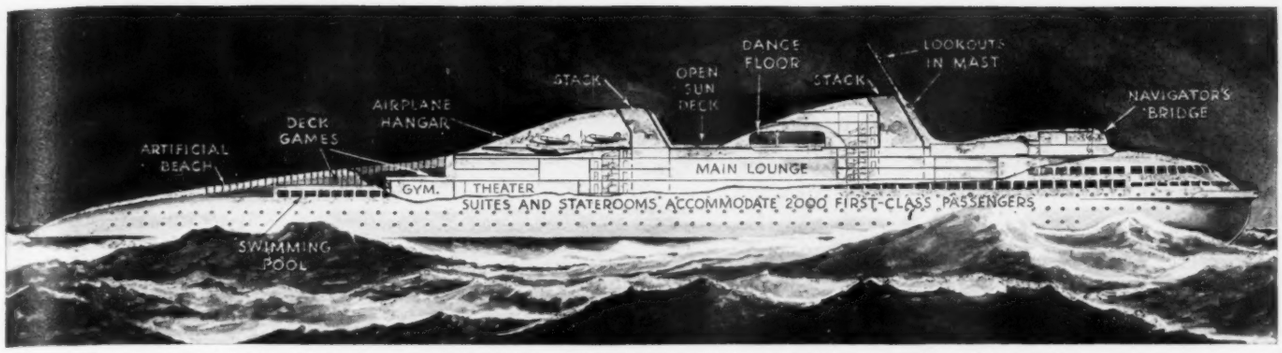
VIKINGS' OLD WAR HORN UNEARTHED IN DENMARK

NEARLY ten feet long, a snake-like horn unearthed in Denmark and shipped to America might well puzzle a modern musician. The rare relic, shown below, was used for signaling by ancient Vikings of the eighth century, when they wished to call their adventurous bands together for council or war. A sounding disk augmented its blast so it could be heard for many miles.



FURNITURE MAKING, HUSTON'S HOBBY

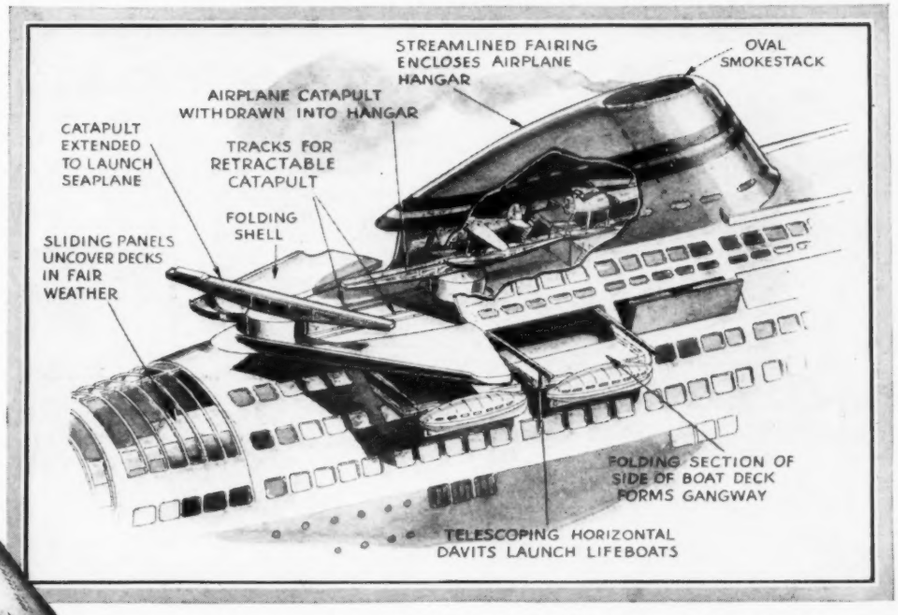
FAMILIAR to many for his impersonations on the movie screen and stage, Walter Huston becomes a home workshop enthusiast in his spare hours away from the studio lot. His cabin in the San Bernardino Mountains of California, where he makes his home, is furnished almost entirely by his own hands. Huston has set aside a commodious room in his basement as a workshop where he produces fine furniture.

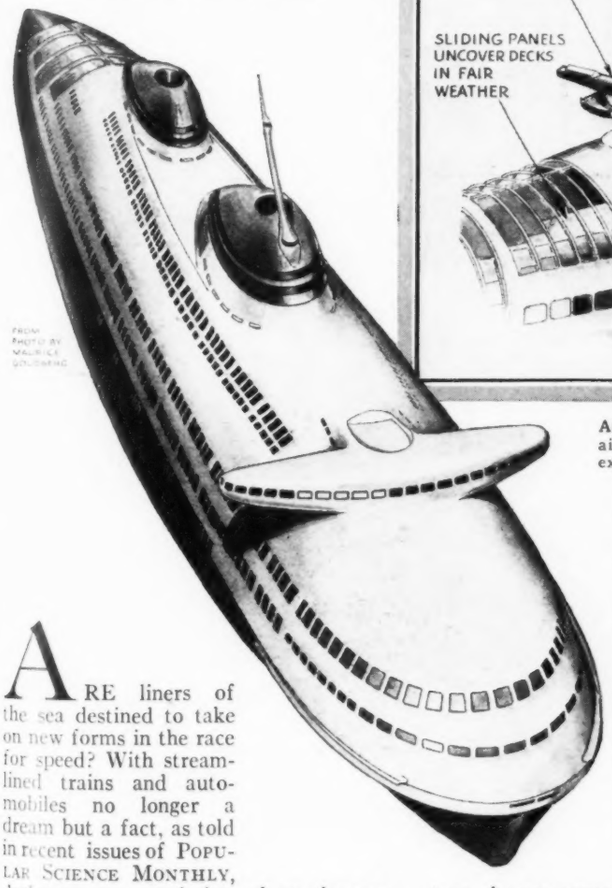


Cutaway view of Geddes' design for a streamlined ship, showing features of liner that will accommodate 2,000 first-class passengers

New Streamlining for Big Ships

Radical Design of Ocean Greyhounds May Shorten Trip to Europe by One Day


STREAMLINED FAIRING ENCLOSES AIRPLANE HANGAR
OVAL SMOKESTACK
AIRPLANE CATAPULT WITHDRAWN INTO HANGAR
CATAPULT EXTENDED TO LAUNCH SEAPLANE
TRACKS FOR RETRACTABLE CATAPULT
FOLDING SHELL
SLIDING PANELS UNCOVER DECKS IN FAIR WEATHER
FOLDING SECTION OF SIDE OF BOAT DECK FORMS GANGWAY
TELESCOPING HORIZONTAL DAVITS LAUNCH LIFEBOATS



Above, some of the streamlined ship's mechanical details, including the airplane hangar, lifeboat-launching apparatus, and means provided to expose decks in fair weather. Left, view showing contour of the vessel

ARE liners of the sea destined to take on new forms in the race for speed? With streamlined trains and automobiles no longer a dream but a fact, as told in recent issues of POPULAR SCIENCE MONTHLY, designers are wondering where the newborn art of streamlining may work additional transformations. That streamlined ocean vessels will prove a logical development is the view of Norman Bel Geddes, noted industrial designer of New York, who since 1927 has been experimenting with ships, motor cars, factories, and railway coaches designed along advanced engineering lines.

Capable of being built and operated successfully under conditions existing today, he maintains, is a 1,088-foot streamlined vessel that he has designed. Details of this striking craft, which he decribes in his book, "Horizons," published by Little, Brown, and Company, give a fascinating picture of what sea travel of the future may be like.

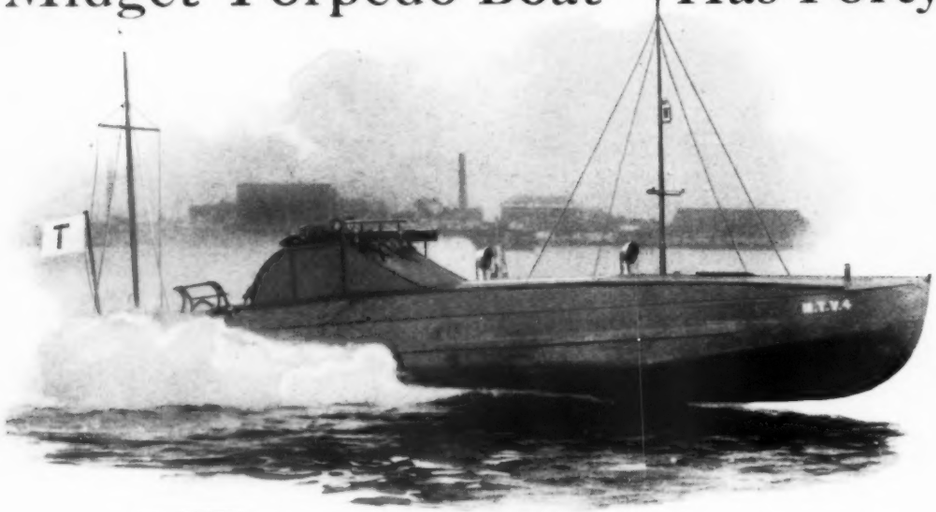
Streamlined both in hull and superstructure, the passenger liner proposed by Geddes presents a striking contrast with present-day vessels. Every air pocket has been eliminated by inclosing the entire superstructure in a streamlined shell. Only the navigator's bridge protrudes, and this is shaped in the form of a monoplane wing so it offers a minimum of resistance to the air.

As a result of its smooth contour above the water line, and improved hull design below water, its designer estimates that the ship's speed in normal weather should be at least twenty percent greater than that of conventional craft, or enough to clip a day from the transatlantic passage. In bad weather the advantage of the streamlined ship would be materially increased because it would not be adversely affected by strong head winds. Tests show the design would reduce wind resistance by about eighty percent.

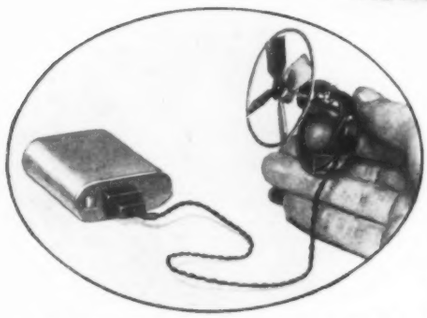
Accommodations are provided on the liner, in Geddes' design, for 2,000 first-class passengers and for a crew of 900 men. Sliding panels of light alloy or glass in the streamlined skin provide for the comfort of the passengers in rain or shine. When the weather is fine, the moving panels are rolled back and the ship is more open than a liner of the present day. In stormy weather the panels are closed and the vessel is as impervious to the elements as a submarine. Thus, the fully streamlined form of the ship is preserved when most needed.

Smokestacks for the steam-turbine power plant of the streamlined craft are inclosed in fairing that makes them seem to dissolve into the superstructure.

Midget Torpedo Boat Has Forty-Knot Speed



CAPABLE of attacking anything from a submarine to a battleship, one of the world's smallest warships has been developed in England. This "pocket torpedo boat," shown undergoing a test at left, measures fifty-five feet in length and skims the water at forty knots. Because of its speed, it can make an effective escape after a surprise raid. The boat carries two torpedoes, two small anti-aircraft guns, four depth charges to be used against submarines, and smoke-screen apparatus. Wireless telephone equipment enables the crew of five to keep in constant touch with ships and aircraft. A dozen of the speedy midgets cost less to build than one large destroyer.



SMALLEST MOTOR RUNS POCKET ELECTRIC FAN

PAUL WELFONDER, German engineer, claims the distinction of having built the world's smallest practical electric motor. Operated by a flashlight battery, its armature spins at 900 revolutions a minute. Mounting a blade on the rotor, the builder has a pocket electric fan.

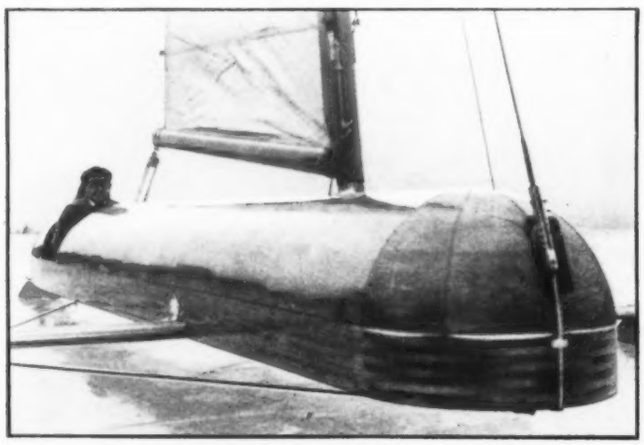
USE ARROWHEADS TO MAKE PICTURES

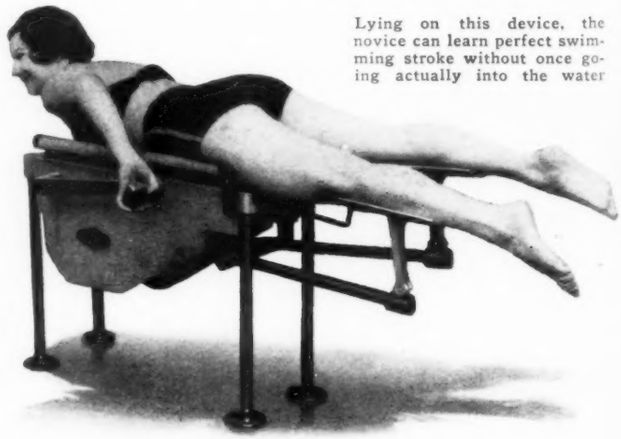
AN UNUSUALLY effectively way to display Indian arrowheads has been devised by Dr. A. R. Wittman, of Merrill, Wisc., whose collection is the largest in his state. The stone weapons serve as the materials for pictorial panels of Indian chiefs, bears, mountain goats, and other scenes and animals associated with Indian life. After an artist has traced the outline of the design upon a background of bristol board, Dr. Wittman selects appropriately shaped arrowheads to fill in the design.

This picture of a storm-driven horse and rider was made entirely of arrowheads attached to the canvas by means of small wires

ICE BOAT IS STREAMLINED

STYLED the "ice Zepplin," a speedy new type of ice boat has made its appearance at recent German regattas. The pilot sits within a cockpit at the rear of a long torpedo-shaped hull, which has a flat bottom and a top that is rounded to a smooth, streamlined finish. Fairing surrounds the tapered headrest behind the pilot to complete the streamlined effect. The odd design gives the craft a striking appearance when viewed head-on, as illustrated in the picture below.





Lying on this device, the novice can learn perfect swimming stroke without once going actually into the water

ROBOT, ON LAND, TEACHES SWIMMING

LEARNING a difficult swimming stroke is made an easy task by a new mechanical instructor, devised by an Oakland, Calif., inventor. When the novice lies upon the device and turns a crank handle, jointed guides simulate the motions of the crawl stroke. By following their motion with the limbs, the student quickly senses the proper timing of each motion, since the guides themselves resist, with gentle pressure, any attempt to make a stroke at the wrong time. The apparatus is designed to give preliminary swimming instruction on dry land, leaving fine points to be taught later.

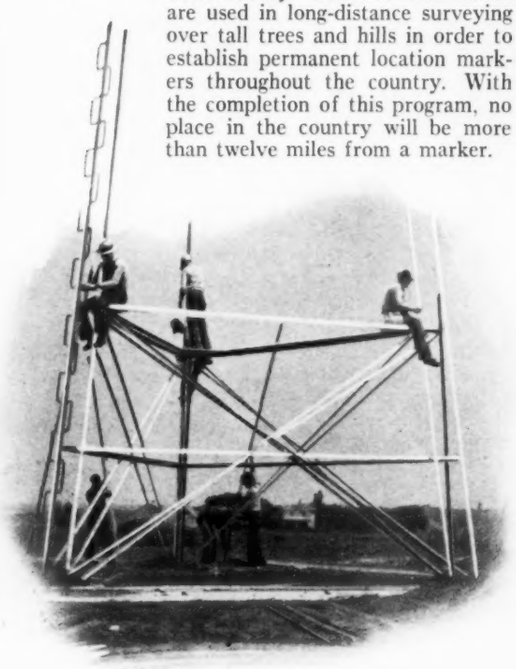
WORKER GOES HOME ON HIS COASTER

At the end of their day's work, laborers in a slate quarry of north Wales start their trip home in picturesque fashion. Each is provided with an odd device known as a "car gwyllt," literally, the car that goes, which is, in effect, a one-man roller coaster. It consists of a single seat, an axle, a small wheel, and a roller. Setting this contrivance upon the quarry track, the workman seats himself upon it and whizzes down the mountainside to the nearby town.

Left, one of the roller coasters used by Welsh quarrymen in sliding down mountain side. Above, workers ready to start their coast homeward

RAISE 146-FOOT TOWER IN THREE HOURS

Erected by six men in only three hours, and dismantled even more rapidly to be taken to another site, a new type of steel observation tower is speeding the work of the U. S. Coast and Geodetic Survey. The 146-foot towers are used in long-distance surveying over tall trees and hills in order to establish permanent location markers throughout the country. With the completion of this program, no place in the country will be more than twelve miles from a marker.



Right, assembling a 146-foot portable tower for surveyors. Above, tower up and ready to use

SHOE-SHINING MITTEN CARRIES ITS POLISH

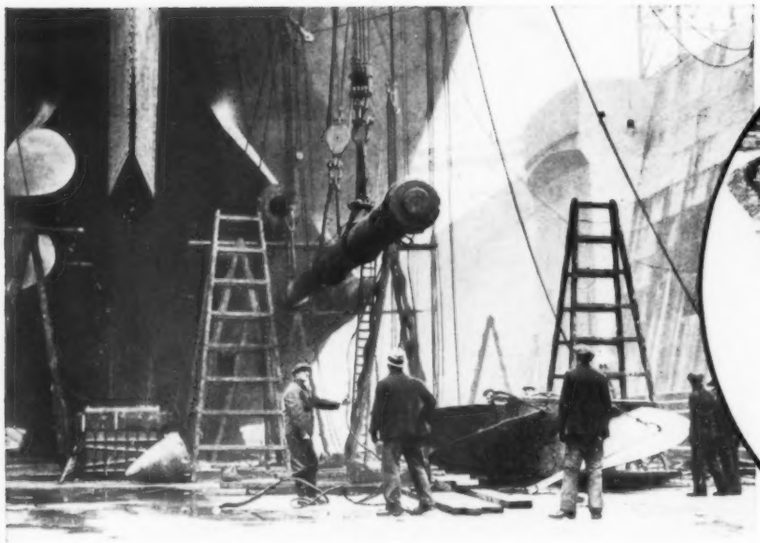
All the essentials for polishing shoes are combined in a mitten recently placed on the market for household use. Small buttons of a special polishing wax are attached to one side of the mitten, as shown in the illustration above, while the other side of heavy flannel serves as a polishing cloth. The two-in-one cleaner is said to give at least 100 shines, and is supplied for use with polishing buttons for either tan or black shoes.

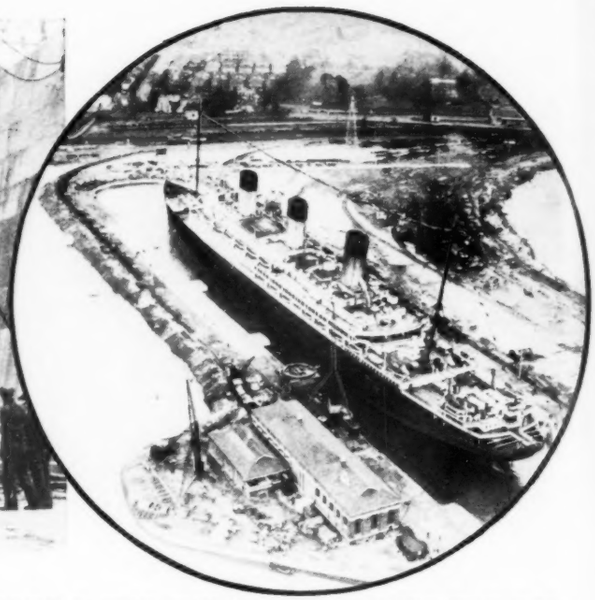
PORT FOR GUNS IN POLICE WINDSHIELD

A windshield, containing a gun port, has been invented by a former Dearborn, Mich., fireman, to guard the lives of police officers during a bandit chase. Thrusting his weapon through the opening in the bullet-proof windshield, an occupant of a police car can fire at escaping criminals without exposing himself. The ball-and-socket port, made of brass, permits a rifle or revolver to be pointed in any direction. At right the inventor is seen demonstrating his model.

STOP LIGHT COMBINES COLORS AND MOTION

A stop light for cars that is plainly visible in sunlight, fog, rain, or darkness, combines action and dazzling colors to secure the attention of other drivers. Celluloid insets, colored red, blue, green, and yellow, are mounted on a revolving disk that spins whenever the motorist steps on the brake which actuates the signal. A convenient bracket enables the signal to be attached just above the car's license plate, in the manner illustrated.





LARGEST SHIP OVERHAULED IN WORLD'S BIGGEST DRY DOCK

Two giants met, the other day, when the S. S. Majestic, largest liner in the world, entered the biggest dry dock ever built. The ship was the first to be overhauled in the new dock at Liverpool, England, which was recently completed at a cost of more than $6,000,000. The normal inside length of this dock, 1,200 feet, exceeds that of the next largest dry dock, at Boston, Mass., by twenty-nine feet, and provision is made for accommodating even longer liners if necessary.

GAS MOTOR IN WHEEL TOWS ROLLER SKATER

Gas motor runs wheel to which roller skater clings and is towed

MOTORIZED roller skating, a sport packed with thrills, has been introduced in Hollywood, Calif. A wheel with a miniature, built-in gasoline motor provides the motive power, and a skater, grasping a pair of handlebars attached to the wheel, is towed at a lively clip.

4,000 PIECES OF WOOD IN MOSAIC TABLE TOP

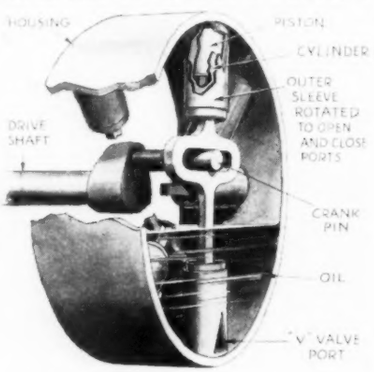
BY GLUING together 4,000 pieces of fir, mahogany, Tennessee red cedar, walnut, and Alaska cedar, Everett Smith, of Hoquiam, Wash., has produced an attractive card table with a mosaic top. It contains a colorful pattern in five brilliant hues, built up by the small blocks.

CAP FOR SHAVING CREAM TUBE IS ALSO A BRUSH

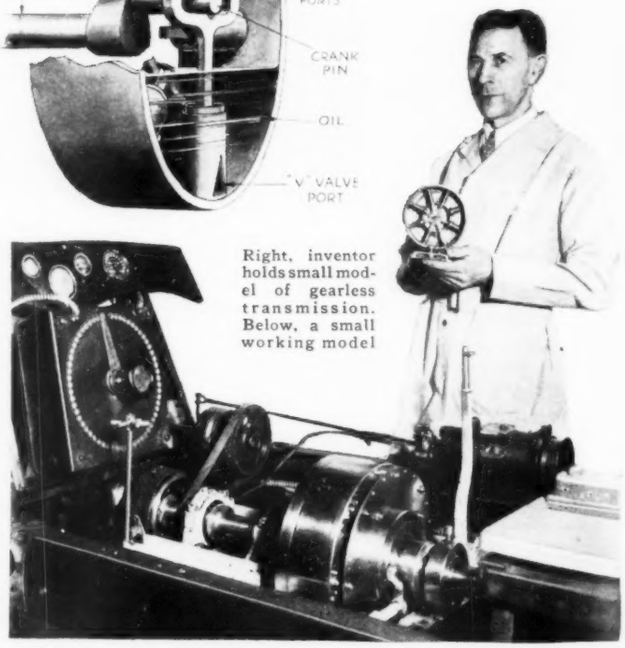
SERVING the purpose of a brush as well as a cap, a new attachment for a tube of shaving cream simplifies the morning toilet. When the cap is attached, pressure squeezes cream upon the applicator, which is then used like a brush.

NEW TRANSMISSION HAS NO GEARS

POWER is transmitted at variable speeds by means of a hydraulic unit invented by A. E. Hedlund of Everett, Wash. Replacing gears in automobiles, it employs a steel case containing eight cylinders with eight pistons working in pairs from a crank attached to a drive shaft. When this drive shaft is rotated, a reciprocating motion is set up in each link acting between opposite cylinders, thus causing one cylinder of each set to pump oil, while each opposing cylinder expels it. In the wall of each cylinder is a wedge-shaped port which may be closed or opened. When these ports are open, the unit runs free, but as the port is closed, it takes up the load.



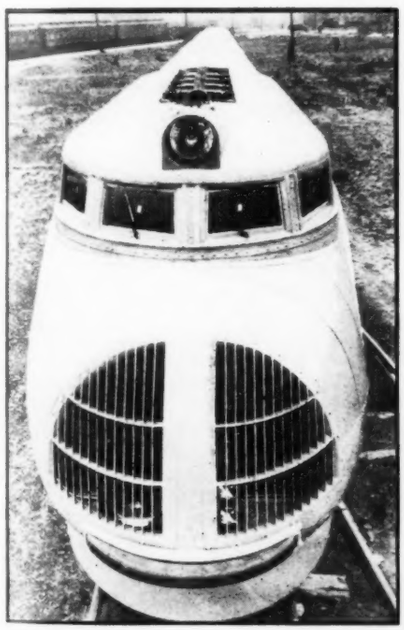
Diagram, left, showing construction and operation of hydraulic transmission in which there are no gears



Right, inventor holds small model of gearless transmission. Below, a small working model

USE WINGLESS ROOSTER IN STUDY OF FLIGHT

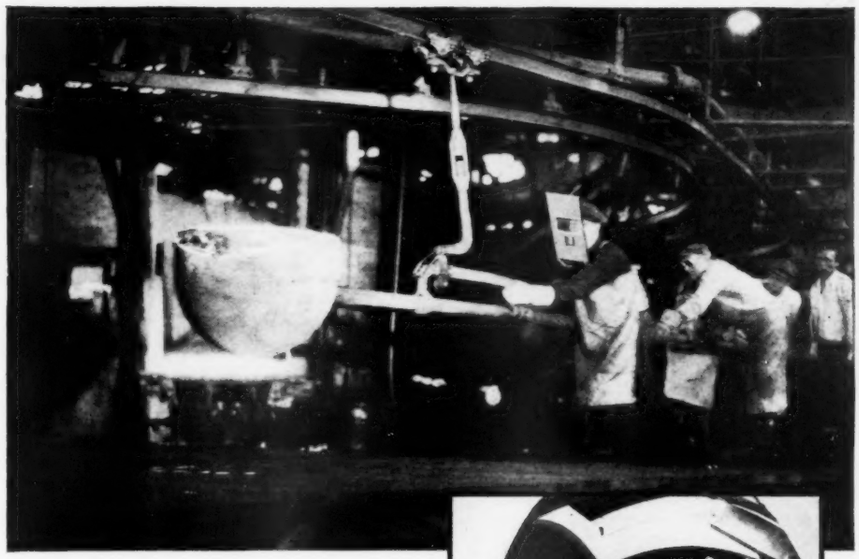
THROUGH a freak of nature, science may soon be able to explain some of the long-standing mysteries of the flight of birds. A rooster, hatched without wings, is now to be studied in the National Zoological Park at Washington, D. C., by experts from the Smithsonian Institution. Six months old, it has shown no inclination to try to fly. Later, by dissection, the experts hope to find why the wings failed to grow, and whether the absence of flying instinct may explain the evolution of flight.



NEWEST SPEED TRAIN LEAVES THE FACTORY

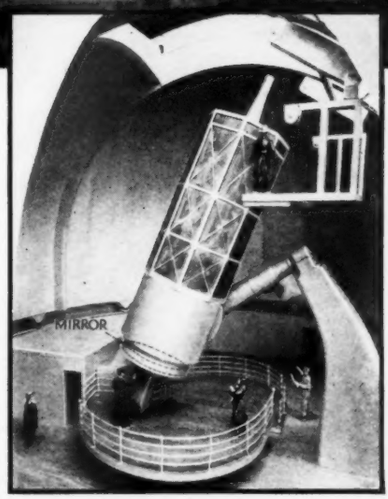
SHAPED like a projectile, the Union Pacific Railroad's 110-mile-an-hour streamlined train has just been completed in Chicago. Its first picture, reproduced above, gives a striking impression of what the swift monster of the rails will look like when it is coming down the rails directly toward the observer. The wide semicircular ports at the front ventilate the cooling system of the train's 600-horsepower motor, which is directly coupled to a generator providing electric current for its propulsion.

POUR THREE-TON TELESCOPE MIRROR



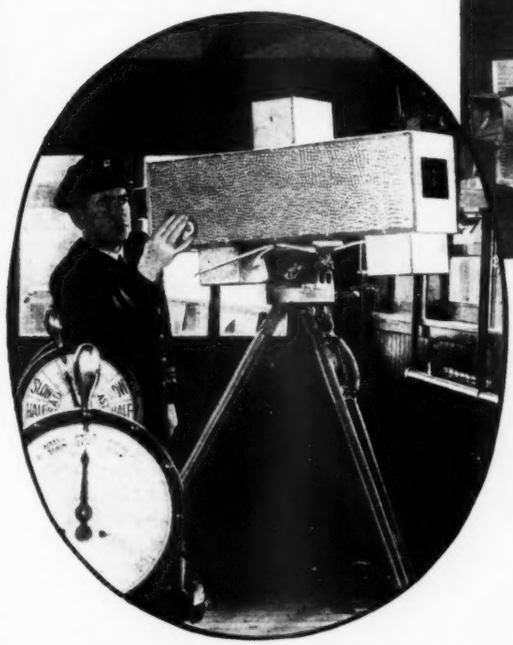
Pouring 5,600 pounds of glass for the McDonald telescope. Note, workmen wear masks

MEASURING nearly seven feet in diameter and weighing almost three tons, the second-largest telescope mirror in the world was successfully cast at Corning, N. Y., the other day. When it has cooled, which will require nearly three months, it will be installed in the new McDonald Observatory of the University of Texas. In the spectacular pouring process, illustrated above, fourteen ladles of molten glass were successively trundled to the mold by masked workmen. Each ladle held 400 pounds of heat-resisting glass. Experiments have shown this type of glass superior even to special optical glass. The same type will be used for the 200-inch mirror in the Mt. Wilson Observatory.



Complete scale model of the McDonald telescope. Its mirror will be world's second largest

FOG-PIERCING CAMERA TESTED ON SEA CRUISE



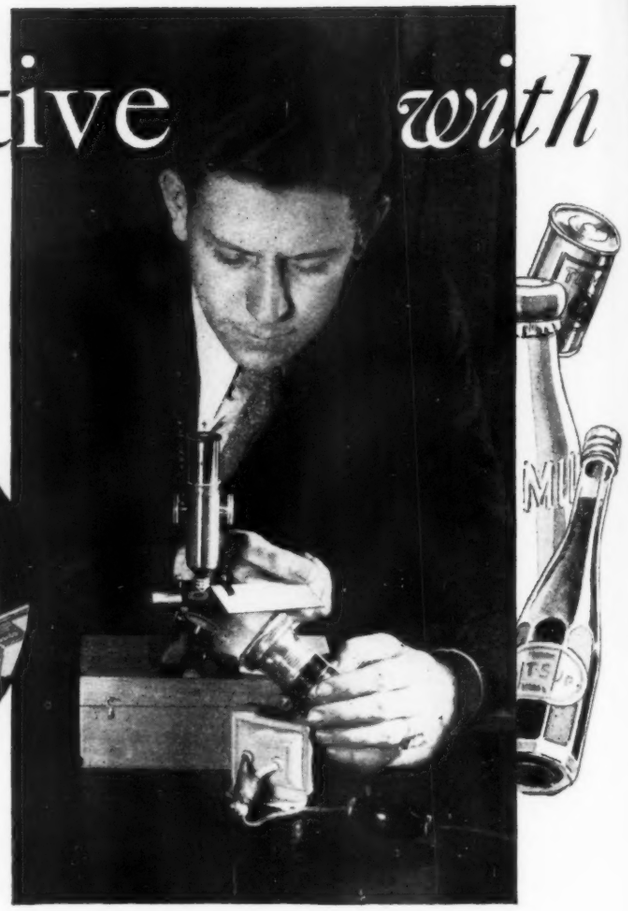
Williams' fog camera in use on liner *Manhattan*. Upper right, developing picture in thirty seconds.

FOLLOWING successful preliminary trials described in a recent issue (P.S.M., Dec. '33, p. 48), the new Williams' camera, that guides ships through fog, recently received a more extended trial during a transatlantic cruise of the liner *Manhattan*. When fog shrouds the entrance to a harbor or obscures a dangerous passage, the new camera is brought into play. Its picture can be developed and fixed in thirty seconds to show what is ahead of the ship, and reveals objects from two to four times as far away as one can see. This is done with plates sensitive to invisible rays.

Be a Detective with

READY TESTS FOR PRESENCE OF STARCH

At left, how a specimen is taken from a potato in preparing to examine its starch grains. Below, using iodine to stain starch grains in flour so they can be examined more easily under the microscope



For dark-field illumination, arrange your light, as above, so it will strike the object obliquely. The cardboard is used to shield the eyes from light

By

MORTON C. WALLING

ALTHOUGH your microscope is an instrument of entertainment that admits you to a world of invisible wonders, it is capable of more serious work. As microscopes are used in commercial and government laboratories in examining and testing all kinds of materials, so you can employ your instrument for analyzing food, cloth, paper, and hundreds of other things found in your home.

It is fun to examine, at 100 diameters, a bit of fuzz plucked from your coat. At the same time, such an examination may show that you have been cheated, that the suit the merchant assured you was "all wool" really is a mixture of wool and cotton. In the same way you can learn, more certainly than in any other, whether many other articles are genuine or, in the case of food, whether it is fit for use.

To be your own microanalyst, you need not possess elaborate equipment or be an expert scientist. Even the most highly-trained microscope specialists employ a system so fundamentally simple that anyone can follow it. Basically it is:

Compare the unknown substance with known materials until you find a perfect match.

Thus by looking through your microscope at specimens of cloth, starches, paper, foods, and other substances whose identity you know exactly, you soon learn to recognize these things when you meet them in strange places. It is like belonging to a club. You soon learn to recognize, on sight, all established members. Some day you will encounter a stranger among the group of club members, but if you go about it in the right way, you will not find it particularly difficult to identify him. Similarly, you can learn the identity of the strangers you find under your microscope by comparing them with known substances, with pictures, or by further observation.

When you first start out to discover the microscopic wonders of your home, and to learn whether your suit is all wool or whether the refrigerator contains anything that is not fit to eat, everything you meet will be more or less strange. Maybe you think that you already know all about the common things you will find—about a potato for instance; but soon you will discover that you previously knew almost nothing.

Here is a small Irish potato, a common spud. Look at it. If you can, by stretching your imagination, decide that it is an object of beauty, you deserve a medal, for you have rare insight. It *is* beautiful and interesting, but not as it stands. With a knife cut a small piece from the potato, scrape the surface until you have a drop of cloudy liquid, and smear some of the liquid on a microscope slide. Into about one tablespoonful of water stir one drop of tincture of iodine. Add a drop of this mixture to the potato scrapings on the slide, and place a cover glass over it. With your unaided eye, you can see the smear take on a blue color. Now put the slide on your microscope stage and adjust the magnification to about 100 diameters.

Who said a potato has no beauty?

The blueish smear has resolved itself into a collection of nearly round jewels, sapphires they seem to be. They are not all of the same size, nor exactly of the same shape; but all are nicely rounded, with no sharp angles or ragged contours.

These particles are potato starch grains, colored blue by the iodine. This coloring action is a standard test for starch. You can add iodine water to any food or other material, and if there is starch present, the characteristic blue color will appear.

Examine one of the grains carefully, at a higher power if possible. You will discover that, like an oyster shell, it is made up of concentric layers. Near one end of the elliptical grain, you see what appears to be a dot or hole. This is the hilum, present in many kinds of starch. Potato starch grains are among the largest of any starch. Their surface markings are more distinct than on most other starches.

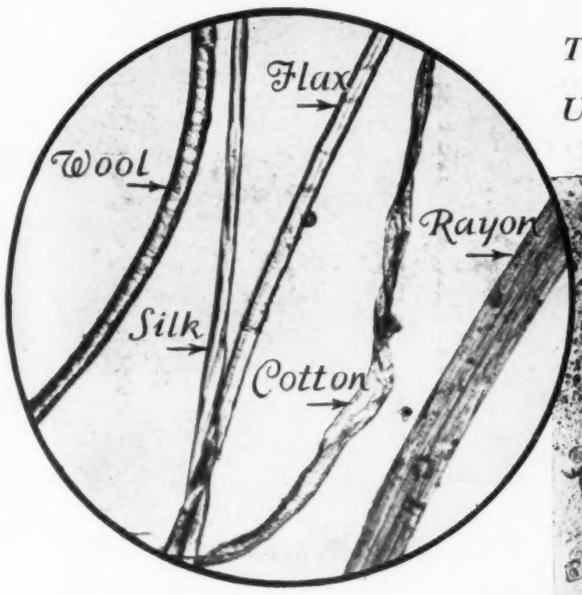
Make yourself well acquainted with potato starch, for you may meet it almost any place during your examination of household foods. Here, for example, is a sack of flour about which you know little or nothing. Is it pure? The microscope will answer that question if properly used, even when chemical and other methods might fail. Flour itself is composed largely of wheat starch, but sometimes the miller can make a greater profit by mixing some cheap potato starch with the flour. You cannot see the difference with your unaided eye; nor can you feel, taste, smell, or otherwise learn that there is a difference. But your microscope will tell you the truth at once.

Sprinkle a little of the flour on a glass slide and moisten it with a drop of the iodine water previously mentioned. Drop a cover glass over the specimen. Your microscope will reveal numerous blue particles, considerably smaller than the grains of potato starch, and more or less circular in shape. These are wheat starch grains. Perhaps you can see the hilum and layers of one or more of the grains.

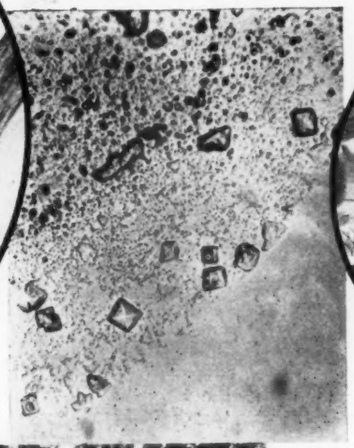
Here in the flour is a blue grain that is much larger than the others. It looks familiar, and you identify it as a grain of

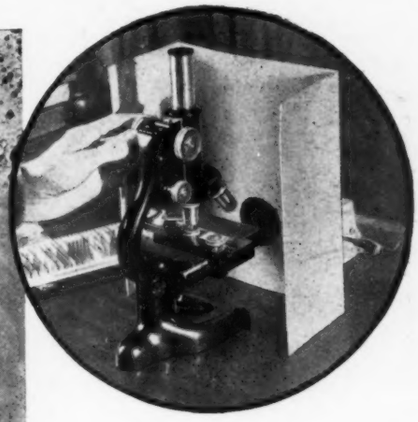
Your Own Microscope

Trailing Hidden Clews and Identifying Many Unknown Substances Is Made Easy for Amateur

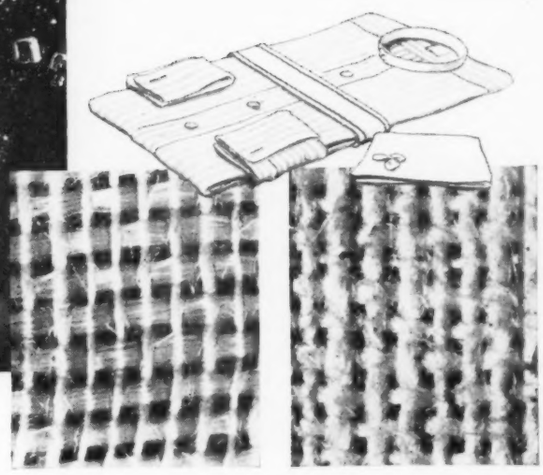


Here are the five principal kinds of textile fibers, each magnified enough to show its nature and help identification. A little study will make the differences readily apparent





A cardboard screen can be arranged around the microscope, as above, to keep the light shielded and help observation



Center top, salt particles in butter seen by transmitted light. Above, the same specimen as seen with a dark-field illumination. These two kinds of lighting are explained in text

Above left, shirt of rayon and cotton, and above right, shirt of linen. The threads of each of these three different fabrics can be identified if separated and viewed with a microscope

potato starch. You find others. The miller, apparently, has been cheating you. But before you complain to the grocer, inspect samples from several other portions of the sack of flour, so that you will get a representative picture. Then make sure that you can distinguish the various kinds of starch grains, by mixing potato scrapings and wheat flour together, and examining the mass under your microscope.

Because starch is one of the commonest materials used for adulterating granular foods, you must make yourself familiar with the other common forms before you can with certainty analyze foods. Leguminous plants, such as beans and peas, contain a starch that is different from other forms. The grains, usually elliptical in shape, have a slit-like hilum instead of the circular form found in wheat and potato starch. You probably will not be able to see the rings or layers.

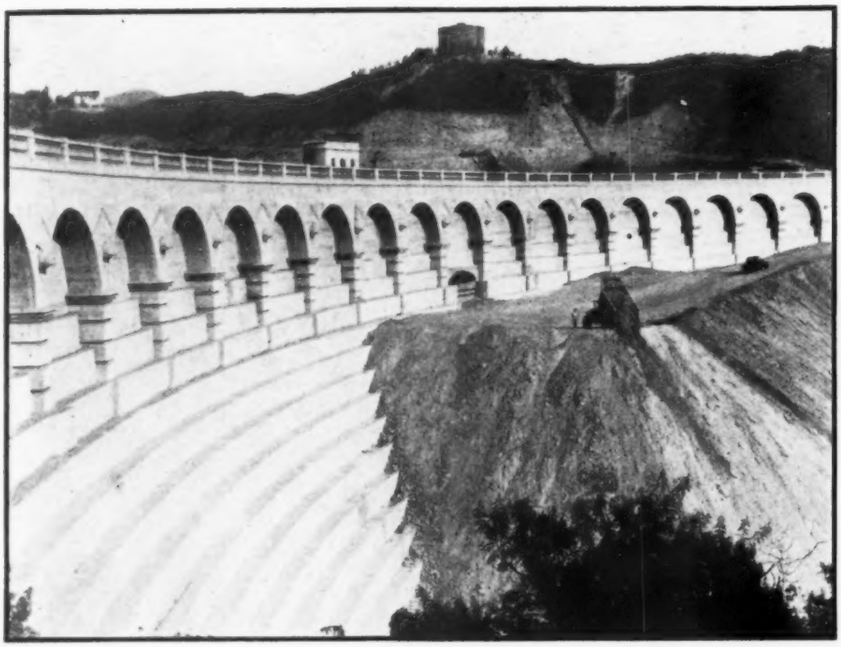
Cornstarch, and that made from rice, are very much alike, but differ from other starches. Their grains are small and are irregular, with sharp corners and edges, and there is no visible layer structure. Grains of rice starch can be distinguished from cornstarch by their smaller size, and their tendency to clump together. Still another form of starch is that occurring in tapioca. The grains, about the size of those of cornstarch, resemble, for the most part, hard-boiled eggs from which a portion of the small end has been cut. That is, they are nearly spherical in shape, but have a flat place which projects a little. The microscope reveals a dot or hollow at the center of the grain.

Starches are not the only foodstuffs you can analyze with your microscope. Perhaps you have a sample of butter that you know little about. Smear some of it on a warm slide, and drop a cover glass over it. The microscope quickly reveals whether the butter is salty or sweet. If it is salty, the cubes of sodium chloride (table salt) will show distinctly, like crystal blocks. Pure butter is made up, for the most part, of small particles of fat and globules of water, evenly distributed. Butters which are composed partly of margerine or other fats and oils usually do not show such even distribution. The water globules generally are larger than those of fat.

Look at ground coffee under a low power, and you will be able to determine roughly whether or not it is pure. Among the materials used as an adulterant for genuine coffee are chicory, bran, burnt sugar and particles of the coffee plant. Small particles of coffee bean, under a high magnification, are seen to be made up of thick-walled cells containing tiny droplets of an oily liquid. The other substances used to cheapen coffee do not contain such cells. Chicory for example, has cells with walls that look fragile.

Sugar sometimes is adulterated with starch, and even white sand has been used, although rarely. You will have no trouble detecting starch by the iodine method.

Microscopic examination is an important means of controlling the purity of milk and cream handled by dairies. Usually the microscope is used to detect the presence of undesirable bacteria, and to indicate excessive numbers of white blood corpuscles which are produced by cows having abnormal or diseased udders. For such discoveries magnifications beyond the range of the *(Continued on page 104)*

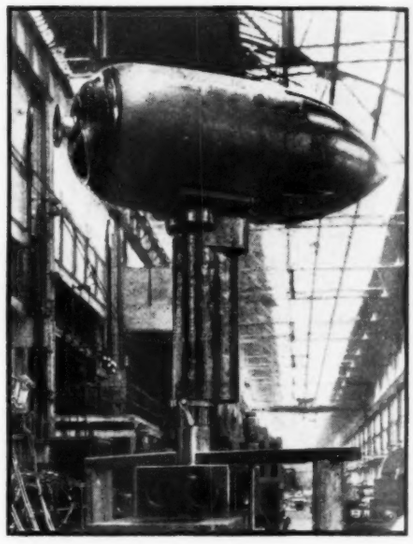


EARTH GUARDS DAM FROM QUAKES

THOUSANDS of cubic yards of earth and rock, now being thrown against the concrete base of the Mulholland Dam in Weid Canyon, Calif., will soon nearly cover the giant structure. The unusual engineering operation is carried out because the dam lies in a section where known earthquake faults exist, and the earth blanket will protect the thickly populated regions further down the valley in case a quake weakens the dam. The photograph shows the blanket being applied.

SEEK WAY TO SILENCE AIRPLANE PROPELLER

TO FIND out why airplane propellers make as much noise as the motors that drive them, and to learn how to correct it, General Electric engineers recently installed at Langley Field, Va., the unusual testing motor pictured below. For test, a propeller is attached directly to the shaft of the motor, which can be turned in any direction, and whirled at varying speed and its noise recorded.



TEST RADIO-OPERATED TELETYPES

TRANSMISSION of weather reports and other data between the nation's many airports, by means of teletype machines, or automatic typewriters, is now done over land wires. Huge sums may be saved if experiments in operating the teletypes by radio prove successful. Recent advances in radio technique have shown this possible, and its practical application would dispense with 13,000 miles of leased wires now in service. At right, government air officials are examining one of the first weather maps sent over the new radio teletype.

Government officials examine weather map sent by radio teletype

SMUGGLERS DETECTED BY X-RAY OUTFIT

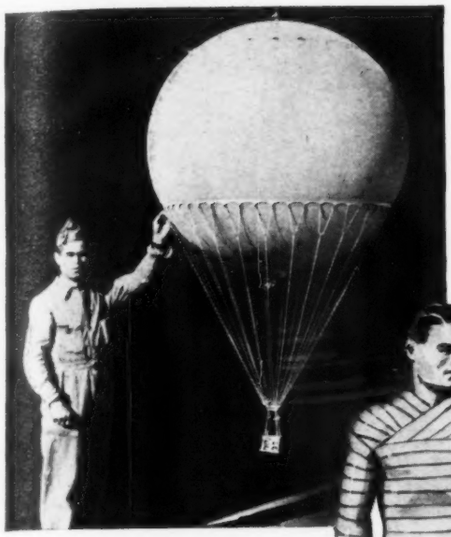
HIDDEN jewelry and contraband materials cannot escape the eye of an inspector armed with X-ray apparatus such as has recently been installed in Dutch customs houses, to thwart the wiles of smugglers. Each traveler is obliged to submit himself and his luggage to examination, as shown above. Honest tourists are thus expedited in their passage through customs while those who have concealed undeclared valuables are caught red-handed.

GLASS COLORED BY SUNLIGHT

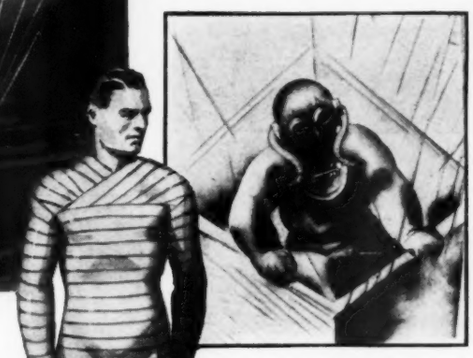
COLORING glassware by the action of the sun's rays has become a profitable occupation in the deserts of the Southwest. The picture at left shows one trader's cache of bottles and flasks, whose clear glass will turn to a purple or amber after two to five years in the sun. The glassware then brings high prices. Scientists explain that the ultra-violet rays change the structure of the glass.

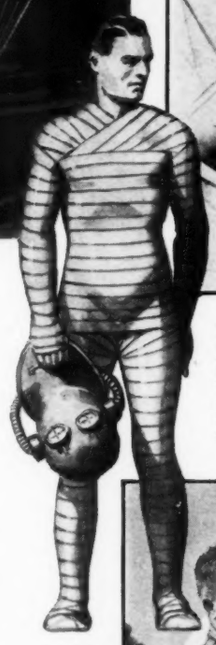
Defy Death in Stratosphere Flight

American Army Officers Prepare to Rise Fifteen Miles in Gondola

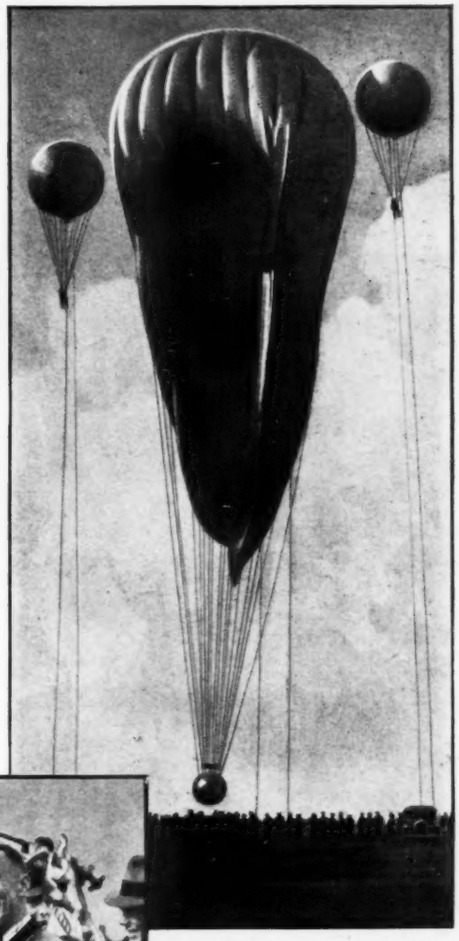


Col. Emilio Herrera, of the Spanish aviation service, with a model of the balloon in which he will make ascent into the stratosphere





Left, Herrera, in his ascent, will wrap his entire body in bandages as shown. This is to enable him to resist the reduced air pressure. Above, the oxygen helmet he will wear to supply him with air



This is the first Russian balloon and gondola used when a new altitude record was set. Men in balloons, seen at left and right, helped the scientists in their take off

Left, Major Chester L. Fordney and Lieut. Commander T. G. W. Settle, just after they landed from their stratosphere flight successful

BENT on soaring to record heights, two Army airmen are scheduled to take off this spring in a balloon as tall as a thirty-story building. Their goal is a fifteen-mile ascent into the stratosphere, where experts believe transatlantic airplanes of the future will fly at 600 miles or more an hour.

When Prof. Auguste Piccard, Swiss physicist, sealed himself within a hollow ball and allowed a balloon to carry him ten miles high, he showed how explorers could conquer this little-known region. After he had duplicated his own feat in a second attempt, others tried it. Russian aviators rose to a record height of almost twelve miles in a sealed balloon gondola. Two Americans, Lieut. Commander T. G. W. Settle and Major C. L. Fordney, nearly equaled this altitude feat with a similar outfit. One of the discoveries made in these ascensions was that the air at such heights, though thinner than near the ground, contains practically the same percentage of oxygen, a fact important in designing stratosphere airplanes, since it showed the air at such levels could be compressed and supplied to occupants of an enclosed cabin, allowing them to breathe without the use of oxygen apparatus.

So successful were these first flights that few realized the peril involved, until three Russian aeronauts set a new thirteen-mile altitude record recently, and paid with their lives for the venture. Others are ready, none the less, to carry on the task of exploring this future airway. The two Army airmen who plan the new venture, Major William Kepner and Capt. Albert W. Stevens, will seek their record in another enclosed gondola. Meanwhile a Spanish aspirant to stratosphere honors may precede them with an even bolder scheme of exploration.

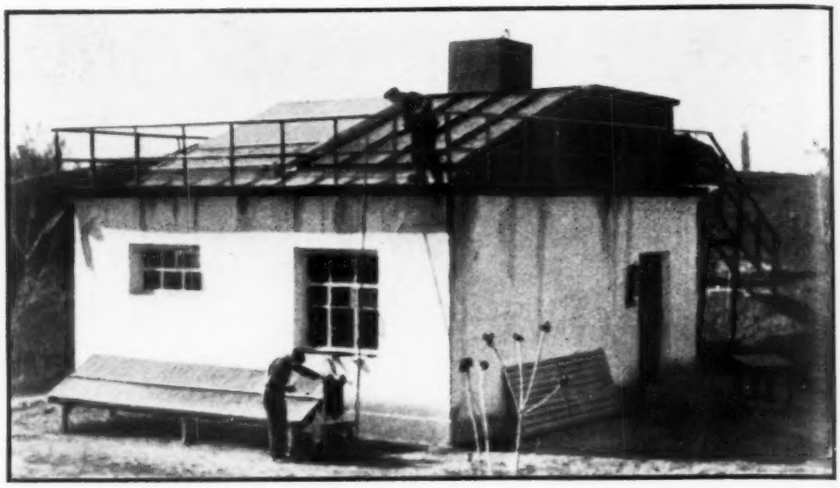
To protect himself from the low atmospheric pressure at the twelve-mile altitude he seeks to reach, Capt. Emilio Herrera of the Spanish aviation service proposes to swath himself tightly in bandages from head to foot. So clad, and covered by an electrically-heated diving suit, he believes he can make the ascent safely in an open basket. Workmen already are rushing to completion a balloon for his perilous venture, in the course of which he plans to make photographs of scientific interest, keeping in touch with the earth meanwhile by radio.

A number of small balloons, like the one shown above, will be released by experts in a comprehensive study of the stratosphere. The instruments they carry will automatically record weather condition. Bamboo frames protect them

A model yacht, anchored on land, goes through motions of a boat at sea. Thus a boy learns to sail

SAILING LEARNED ON DRY-LAND VESSEL

YOUNGSTERS may enjoy the fun of sailing and learn its art, without the danger of actually putting to sea, through the invention of the realistic dry-land craft shown above. Any back yard serves this captive boat for a lake, and its trim sails puff out in the wind as gracefully as if it were floating on water. A frame supports the craft through a universal joint, allowing it to heel over in the breeze and to be steered toward any point of the compass exactly like a real boat.

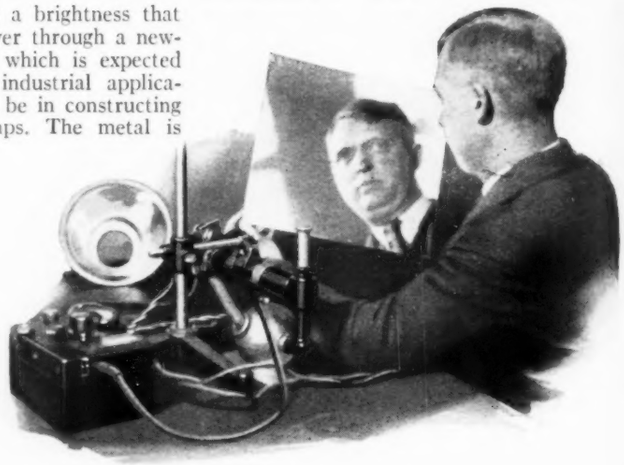


SUN BOILS WATER IN 45 MINUTES

DREAMS of harnessing the sun for the practical development of power are brought nearer realization in experiments now being conducted by Russian scientists. Solar boilers of a new design, installed in a desert station, have heated water to the boiling point in forty-five minutes, and attempts are now under way to apply the plan on a larger scale. The picture above shows the boilers.

ALUMINUM MADE BRIGHT AS SILVER

ALUMINUM is given a brightness that approaches that of silver through a newly discovered process, which is expected to have far-reaching industrial applications. Its first use will be in constructing reflectors for floodlamps. The metal is immersed in a secret chemical bath through which electric current is passed. The resulting electrolytic action dissolves out the impurities in the aluminum and leaves it with an extraordinary brilliancy. By repeating the process a weather-proof coating is added.

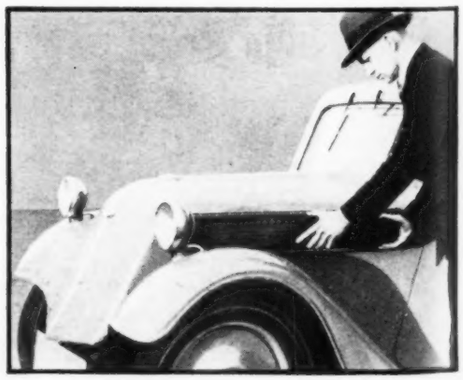


ANIMAL PAINTERS HAVE ART SCHOOL

Cows and horses serve as models at a school for animal painting in Munich, Germany, called the only one of its kind. Students entering this school embark upon a five years' course designed to teach them the fine points of painting domestic animals. In the mornings, a horse serves as a model.

THREE-WHEELED CAR HAS SPARE TIRE UNDER HOOD

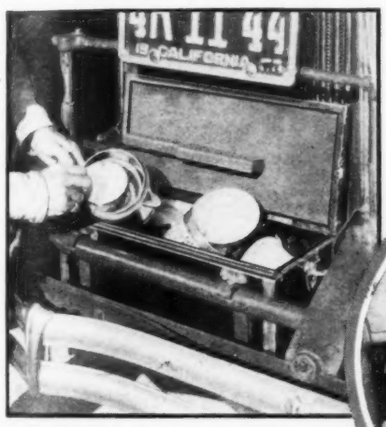
THREE-WHEELED cars, popular in Germany because of their economy, present an unusual problem in the placing of the spare tire. One manufacturer has solved it in the ingenious manner pictured below. The spare is slipped out of the way in a special compartment just under the hood.



Road Scout's Car Is Traveling Home

ANYWHERE on the road is home to "Outdoor" Franklin, California road scout for the Richfield Oil Company, whose ingenuity in remodeling his car to provide for his comfort on long trips would arouse the admiration of any camper. His meals cook while he drives, his clothes remain neatly pressed in a compact chest of drawers, his drinking water keeps cool in an insulated compartment at the rear, and at night he sleeps on air. Although his car differs little in outward appearance from any other on the road, examination reveals an elaborate array of compactly built-in aids. A telescoping gasoline stove and an oven heated by water from the radiator, provide cooking facilities, while cupboards between the front springs and on the running board hold pots, dishes, and supplies. An icebox, curved to fit a front fender, keeps food cool on the hottest days. A trunk at the rear carries suitcases, shaving equipment, and five gallons of water accessible through an outside faucet. By folding back the front seats a bed is quickly made.

A flat gasoline stove on the running board is instantly available when the driver wants to prepare his breakfast

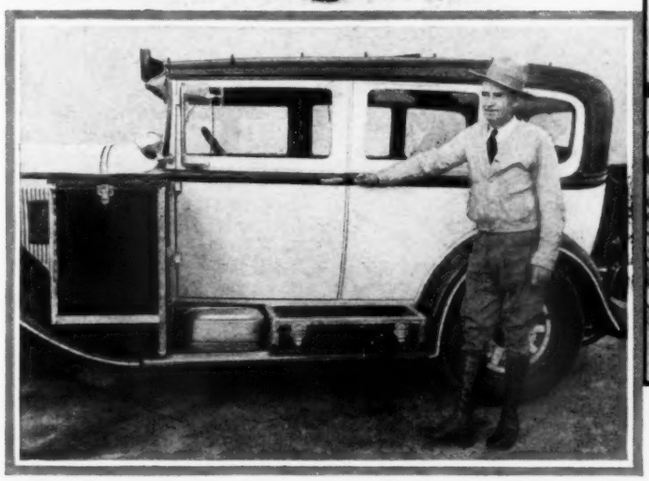


Directly back of the front bumper of this traveling home, is the cupboard in which dishes are carried

Curved to fit the fender, this icebox keeps food cool even on the hottest days. Ice can be chipped out, as desired, and be used to cool the water

Folding back the front seats and pumping up his air mattress, as at right, a comfortable bed is quickly made

Part of the road scout's equipment includes a tight tent that can be raised in five minutes. Its top extends over the car and it has a rainproof canvas floor

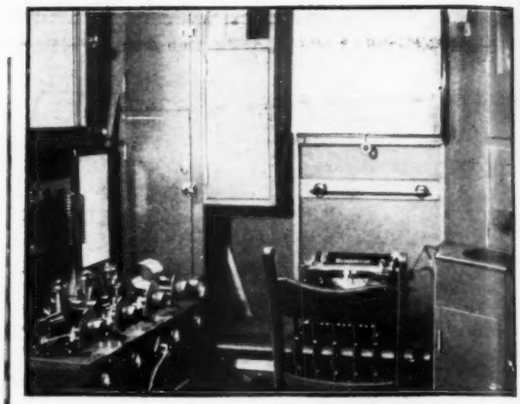


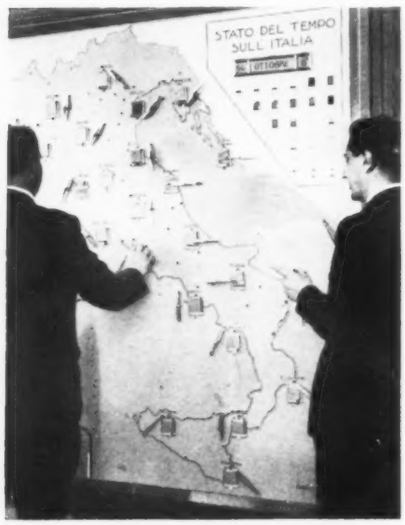
On the running board are a chest of drawers, an oven and a pantry. They are so arranged they do not interfere with the doors

At the back of the car is a cork-covered container in which five gallons of water are carried. A faucet makes it an easy matter to draw a drink

TRAVELING SHORT-WAVE OUTFIT

When L. A. Morrow, radio amateur of Springfield, Ohio, goes traveling, he takes his radio station W8DKE with him. To compare the results of short-wave transmission and reception in different parts of the country, this enthusiast transformed his outfit into a station on wheels, housing it in a two-wheel auto trailer that he constructed of pressed wood material on a wooden frame. To erect his 66.5-foot antenna, he has only to set up a jointed pole carried in the trailer, attaching the other end of the aerial to any convenient tree. When a 100-foot flexible cable is connected to the nearest electric light line, the station is ready for operation.





Below, portable short-wave station made by placing a home outfit on wheels. It is used to compare short-wave reception in various parts of the country. At right, interior view of the rolling station

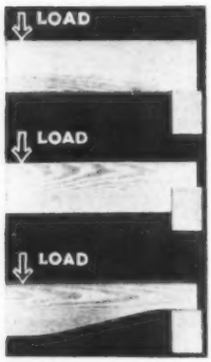
FLYING CONDITIONS OF NATION SHOWN ON MAP

Kept up to date by frequent weather reports, an unusual map just installed at the Rome headquarters of the Italian Air Ministry shows nation-wide flying conditions. Symbols inserted upon a map of Italy at the location of each observing station indicate visibility, wind direction, cloud height, and other factors important to aerial navigation. A glance at the chart gives a clear idea of flying conditions all over the country.

WOOD MODEL SHOWS BEHAVIOR OF GAS

At the University of California, a student has constructed the curious model illustrated at the right. It shows graphically the behavior of a substance in its various physical states. Sections of ply wood, of which the models is built up, are stained in four colors to indicate the action of gas, liquid, and other forms in which carbon dioxide exists. A hinged joint permits the model to be opened for inspection at a point at which gas forms.

TESTS GAGE STRENGTH OF NOTCHED JOISTS



Testing the comparative strength of joists after they had been notched in various ways, experts of the U. S. Forest Products Laboratory recently discovered a fact important to home builders. When joists are cut away at the ends in order to lower a floor to a desired level, the usual practice is to make a rectangular notch. New tests reveal that this leaves the joist weaker than if an additional section were cut away. Trials showed that if the joist in the top view could support 1,000 pounds, the one below it could hold a load of only 250, and the bottom one 500 pounds.

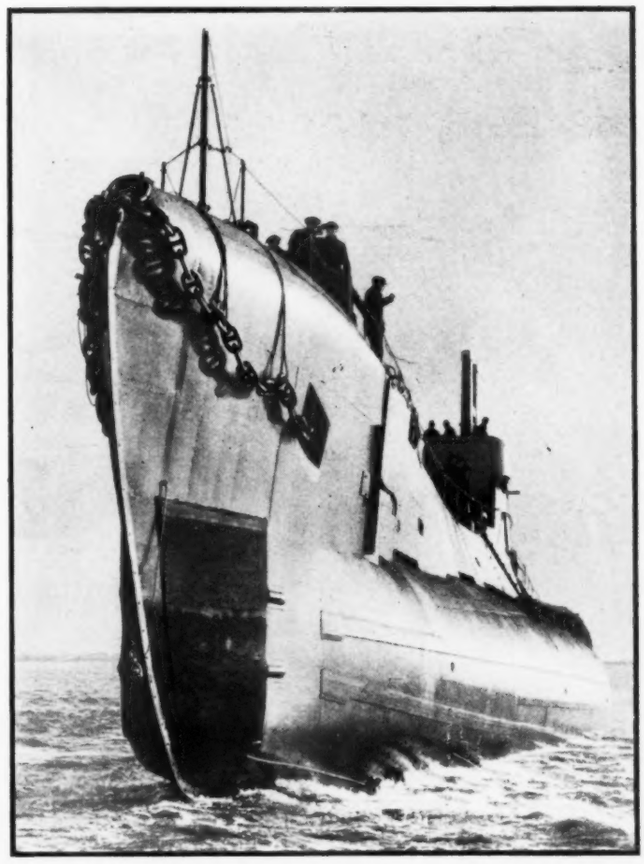
Shadowonscreen helps designer checkaccuracyof finished product

USE PROFILE SHADOW TO EXAMINE GEARS

To determine whether small gears, ratchet wheels, and other irregularly shaped objects correspond to the designs used in their manufacture, a desk-type profile projector has been developed. The object is placed on a glass platform as at left and its magnified shadow is thrown, through a system of mirrors, upon a translucent screen. By placing a large-scale drawing or tracing upon the screen, the outlines of the part may be directly compared with that in the drawing. Special illumination permits interior features to be projected and examined.

STRIKING VIEW OF NEW SUB

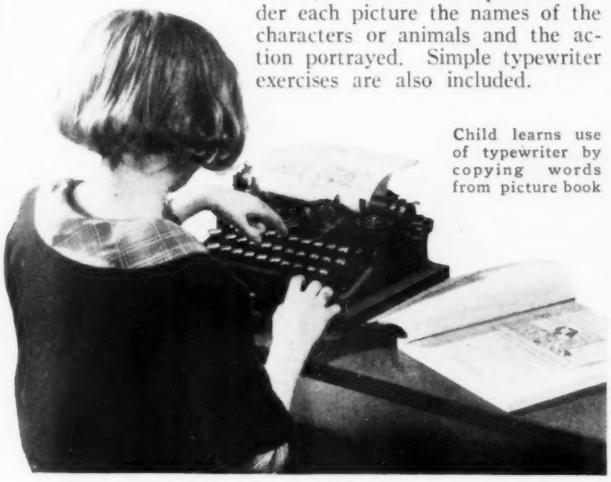
LATEST addition to the British Navy, the powerful submarine *Severn* slid down the ways at Barrow-in-Furness, England, the other day and was snapped just after the launching, in the striking view reproduced at the right. A towering prow and bulging sides give the vessel a fantastic appearance. Besides its torpedo tubes, the *Severn* carries deck guns of sufficient caliber to make it a respectable adversary in surface combat with enemy destroyers.



England's newest submarine photographed immediately after it had been launched. Note its bulging sides, giving an unusual appearance

BOOK FOR TYPEWRITERS

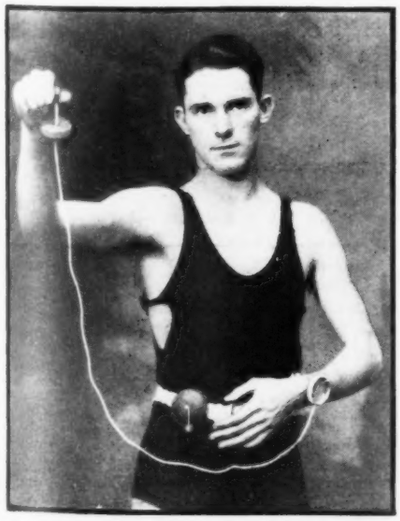
HELPING children to learn to read, write, and use the typewriter is the threefold purpose of a picture book just published, which is called the first of its kind. Its perforated pages may be detached and placed in a typewriter, so a child can spell out under each picture the names of the characters or animals and the action portrayed. Simple typewriter exercises are also included.



Child learns use of typewriter by copying words from picture book

SWIMMER'S LIFE LINE IS WORN ON WRIST

WORN on the wrist or belt, a new life-saving appliance aids in the rescue of a swimmer in distress. The device consists of a cork float and handle, a coil of light but tough cord, and an aluminum receptacle. If the bather feels himself sinking, he pulls the float from its cup at the instant of calling for help. The cord unreels automatically, and rescuers can haul the victim to the surface, as soon as they reach the float, thus materially speeding the recovery of a drowning person.



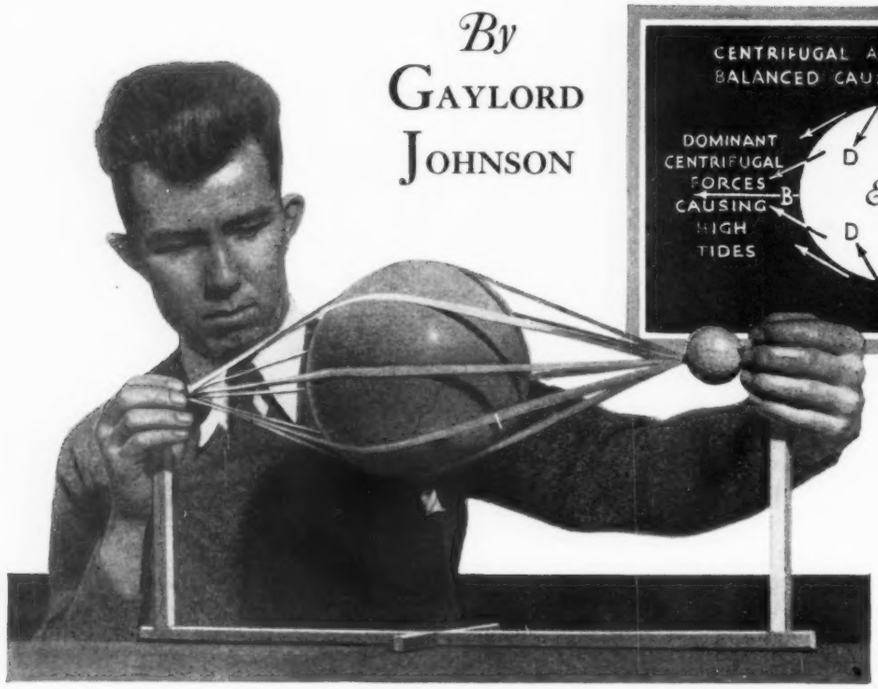
Life line, with float attached, is worn in a cup on swimmer's wrist for use in need

TIMING CONTROL DIALS RADIO FOR YOU

INVENTED by a California woman, a new timing control enables a radio fan to select his evening's entertainment in advance and enjoy it without twisting dials. He has merely to punch a selector web, just as a conductor punches a transfer, selecting the time and the station desired. This ribbon then tunes in and out the different programs, and can select as many as fourteen stations at five-minute intervals. In other adaptations of the new timing control, it is used to unroll an automobile itinerary automatically before a driver's eyes, to remind a professional man of his appointments, and to act as a feeder for a speaker's manuscript.

Above, radio set using the new time control and the ribbon that is punched to select the desired stations. Left, automobile road chart run by time-control device

By
GAYLORD
JOHNSON



FORCES THAT CAUSE TIDES IN THE EARTH'S OCEANS

Direction and strength of forces causing the earth's tides are illustrated above. At A the centripetal pull of the moon exceeds the average force of the earth's opposite pull and the water moves toward the moon. At B, the opposite condition exists and the water moves away from the moon. At C the pull of earth and moon are balanced so the water presses toward the earth's center. At D a combination of the forces acts parallel to earth's surface causing tides to move across the oceans. At left, balloon model of earth, compressed between rubber bands shows how the watery envelope of the earth is distorted by centripetal and centrifugal forces of the earth and moon

RUBBER BANDS, A BALLOON, AND A GOLF BALL SHOW . . .

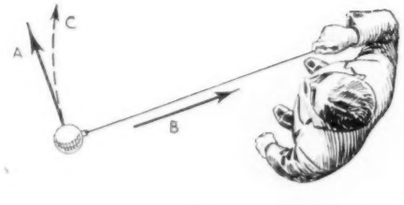
How Moon *and* Sun *Generate the* TIDES

IF YOU ask a school boy what causes the tide in the ocean he will tell you, "The moon, of course! The attraction of the moon pulls the water of the oceans toward it. The attraction of gravity heaps up the water on the side of the earth toward the moon and so the tide rises as the waters pile up."

That is about all that the boy's knowledge covers. You will puzzle him if you ask, "Why are there two high tides every day, while the moon is crossing the oceans only once?" This question will also puzzle nine out of ten grown people.

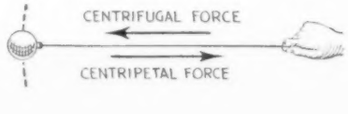
The tenth adult will try to explain that there is another heap of water on the other side of the earth, the side away from the moon. Then he will add that the two heaped-up places in the ocean account for the two daily flood tides, while the low places in between account for the two daily ebb tides. Probably this will exhaust the exceptional adult's familiarity with the mechanical activities of the moon, sun, and oceans.

Yet the forces that produce the exceedingly varied tidal movements to be witnessed daily on the coasts of all the continents can be illustrated clearly by means of a few ordinary objects easily obtained.



If I drive a staple into an old golf ball, tie a string to the staple, and whirl the ball around my head, the string is thrown into a state of tension, which faintly suggests the force of gravity acting upon both the earth and the moon. We will disregard the sun for the present.

If I whirl the golf ball so violently that the staple is pulled out, the ball will fly off in a straight line, a line which is a tangent to the circle in which it was forced to travel by the string. The moon would do the same thing if the force of gravity which holds it to the earth were to be suddenly annihilated.



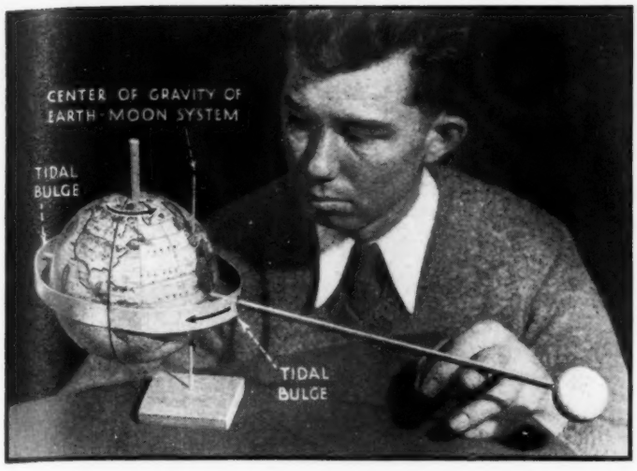
If we make a picture of the forces acting on the ball and my hand, through the string, it will look something like the illustration in the center column of this page. Bear in mind that everything which is true of these two forces will still remain true if we imagine my fist replaced by the earth and the golf ball by the moon.

The force represented by the arrow A would, as we just saw, make the golf ball fly off at a tangent if it were suddenly released from the force of my hand acting in the direction of the arrow B. These two forces struggle against each other and constantly compromise by drawing the ball along the curve of the dotted arrow C. I have drawn the arrows of the same length to show that the forces A and B are balanced, and therefore equal in strength.

I can feel this moon against earth struggle taking place in the string as I whirl the ball around my head. The momentum of the ball tries to resist the force my hand exerts to keep it traveling in a circle.

Can we represent the contest in the string? Certainly. If, ignoring the circular motion of the ball, I try to represent the two opposite forces that struggle in the

Mechanical Forces That Pile Up Oceans on Every Sea Coast Twice Each Day Are Clearly Explained



CENTER OF GRAVITY EFFECTS THE TIDES

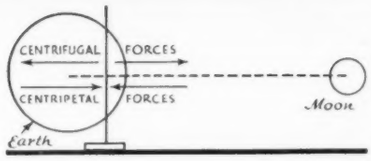
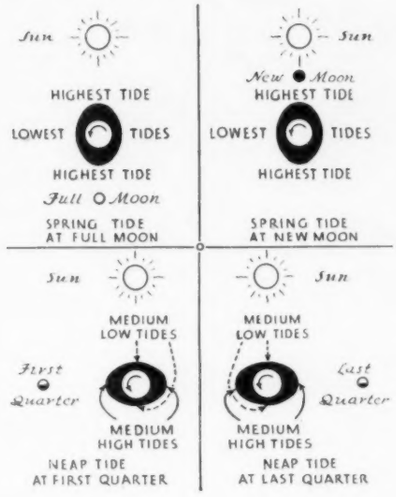


Illustration above shows how the earth and moon revolve about their common center of gravity, represented by the knitting needle. Two tidal bulges, which follow the moon, represented by the paper loop surrounding the globe, travel as great waves across the earth's oceans. Diagram suggests manner in which earth-moon system is kept in constant balance

HIGH TIDES EXPLAINED

Two upper diagrams at right explain high tides as the result of the gravitational pull of the sun acting in line with that of the moon. These are called Spring tides. The two lower diagrams show the sun's force acting at right angles to the moon's effect. The result is seen in the low tidal waves, called neap tides. Note, the moon exerts the dominating force over the ocean's tides



WHY TIDES OCCUR NEARLY HOUR LATER EACH DAY

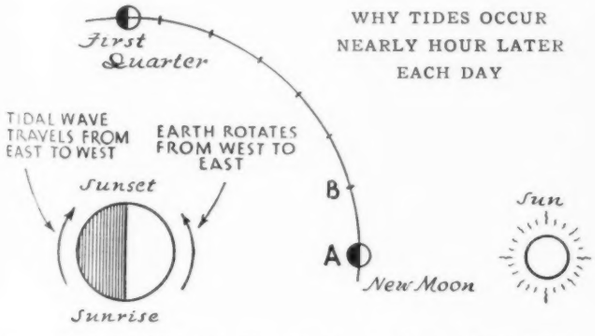


Diagram above shows how moon travels from A to B in 24 hours while the earth rotates once on its axis. As a result the moon rises about 50 minutes later each night. So tides also will rise later

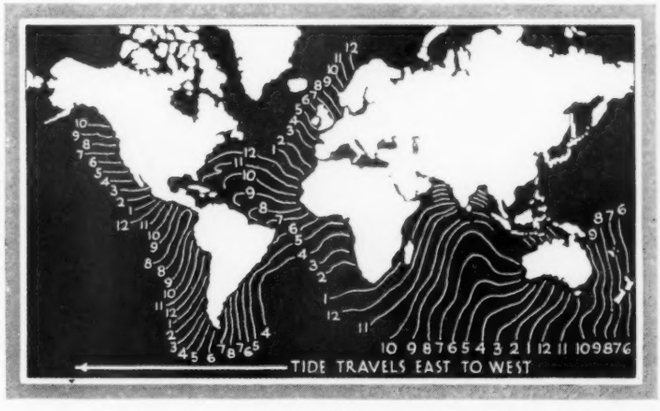


Illustration above shows how the tidal wave starts principally in the South Pacific, moves into the Indian Ocean, rounds Africa, and passes up the Atlantic. Thence it sweeps around South America to the Pacific Ocean

cord, they can be represented by two arrows of equal length, pointing in opposite directions, as shown in the drawing at the bottom of the opposite page. We will call the arrow A the centrifugal force, and the arrow B the centripetal force.

When we imagine that the cord attached to the staple and held in my hand is replaced by the force of gravity acting between earth and moon, we must take an additional condition into account. In other words, the string is not a perfect symbol for this bond of gravitation.

Why? Because the centrifugal force of the whirling golf ball pulls my hand at the single point where my fingers grasp the string. And in the same way the centripetal force of my hand drags upon the ball at the single point where the string is tied to the staple.

The cord is not a perfect comparison for the force of gravity because the bond between our heavenly bodies does not act from a single point in one to a single point in the other. Every particle of the moon attracts every particle in the earth.

Let us put it a little differently, for convenience, and say that the sum of all the particles in the moon (or the entire moon's mass) attracts the various parts of the earth with forces of varying strength. The strength of these forces will vary according as the parts of the earth are nearer or farther from the moon. The nearer the parts to the moon, the more strongly they are attracted, and vice versa.

On the opposite page is an illustration of this situation. The earth's radius being 4,000 miles, the moon is distant from the earth's center by sixty times the earth's radius, or 240,000 miles. Then the moon is distant from the far side of the earth by sixty-one times the earth's radius, and from the near side by only fifty-nine times the earth's radius.

Accordingly, the water of the oceans on the near side of the earth will be attracted to the moon by a slightly stronger force than that exerted by the average attraction of the moon for the center of the earth. Also the waters on the far side of the earth will be pulled toward the moon by a slightly weaker force than that which the satellite exerts at the earth's center.

It is these differences in forces that cause the tides.

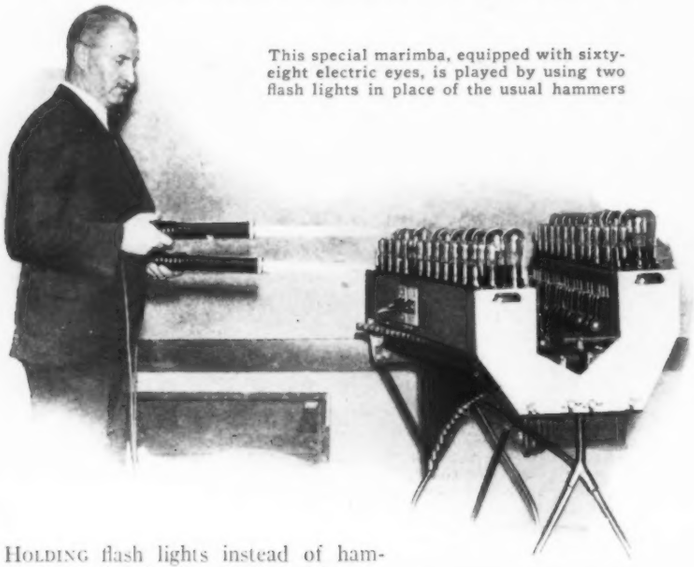
In the illustration at the top of this page, you will see that the moon does not really revolve around the earth's center, but the earth and moon both revolve around their common center of gravity (P. S.M., March, '34, p. 40). Accordingly, both earth and moon tend to pull away from their common center of revolution with centrifugal forces, and both are bound to their center of revolution by centripetal forces.

When you understand this point, you will understand how the tides are caused, for the waters nearest the moon are attracted by a centripetal force stronger than the earth's average centrifugal force. Accordingly, the waters are raised toward the moon in a heap.

Now take the oceans on the opposite side of the earth, on the side away from the moon. There the waters are attracted by a weaker centripetal force than the earth's average centrifugal force. Accordingly, the waters are thrown away from the earth by the dominating centrifugal force and rise into a heap which piles up in the direction away from the moon.

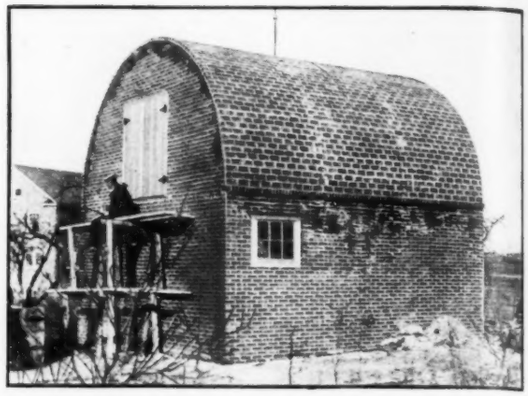
After the effect of the moon's attraction upon the oceans is clearly understood, it is easy to see how the sun's pull modifies the height *(Continued on page 111)*

FLASH LIGHTS PLAY MARIMBA



This special marimba, equipped with sixty-eight electric eyes, is played by using two flash lights in place of the usual hammers

HOLDING flash lights instead of hammers in his hands, Dr. Phillips Thomas, Westinghouse research engineer, recently demonstrated a new type of musical instrument that can be played with beams of light. The instrument, a special marimba, has been fitted with sixty-eight electric eyes and amplifying tubes. Whenever a light beam falls upon one of the cells, a corresponding tone of the marimba is automatically sounded. Through this unusual arrangement, a practiced player can render even complicated melodies.



NEW TYPE BARN IS FIREPROOF

DECLARED the first of its kind, an experimental barn, built by an association of brick manufacturers, is undergoing tests near Burlington, N. J. Because of the new type of brick construction used, no supporting forms were required in its erection. Walls, floor, and ceiling are reinforced with steel rods, which also aid in supporting the roof.

IMPROVED CLAMPS HOLD HARNESS FOR SEWING

TO AID farmers in repairing their harness, an inexpensive and practical substitute for the old-fashioned stitching horse has been invented by Prof. L. M. Roehl, of the Cornell University Department of Agricultural Engineering. His new clamp is mounted by means of three screws to a sawhorse or board, which the operator straddles to use the tool, as shown at left. Pressure applied with the left leg clamps the movable jaws upon the work, the jaws being locked by a self-acting latch bar. When the work is done, the bar is lifted with the right knee and the jaws automatically spring apart.

SMELL METER TESTS PURITY OF WATER

FAR more rapid than any known method of chemical analysis, for detecting impurities in drinking water, is a new "smell meter" developed by Harvard University experts and illustrated above. Consisting of an air pump with a mercury piston, it first is filled with pure air. Small measured quantities of the water under test are then introduced, and an observer notes the moment at which the first sign of odor can be detected. One of the first tasks of the new meter will be to investigate more thoroughly a recent discovery by chemists connected with a New Jersey water company that a badly insulated underground wire or even a radio grounded to a pipe may turn water pink, blue, or green and give it an undesirable odor.

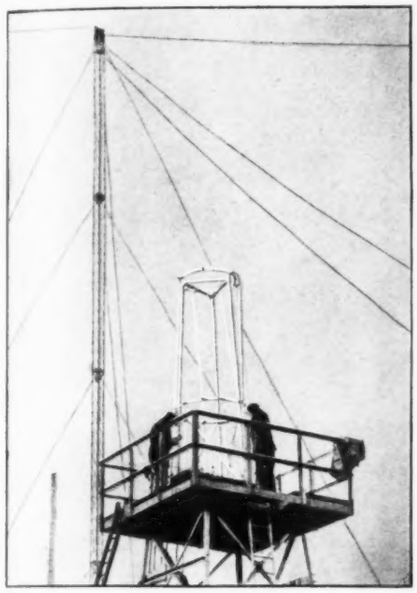
Two hinged vanes on a mast above the wing control this glider so it cannot slip or pitch

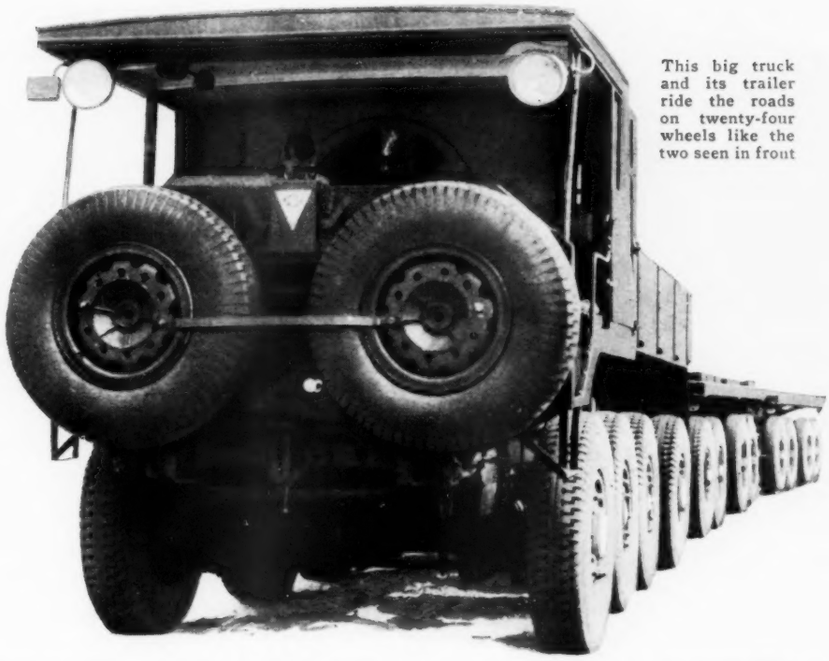
VANES ON MAST KEEP GLIDER LEVEL

SUCCESSFUL in its first test flights, a glider with an unconventional stabilizing device has been introduced by a French inventor. The stabilizer, carried on a mast above the wing, is used to correct any tendency to pitch forward or side-slip in flight. Its two hinged vanes are so wired that they may be folded flat or spread sideways by a control in the hands of the pilot, and thus stabilize the plane.

NEON LIGHTS ON RADIO MAST WARN FLYERS

To FORESTALL an aerial accident such as recently cost ten lives in Belgium, when an air liner collided with a tall radio mast, the towers of the broadcasting station at Rugby, England, are being equipped with neon danger signs. The glow of the tubes, shown in the photograph below, will warn airmen to fly high over the station.

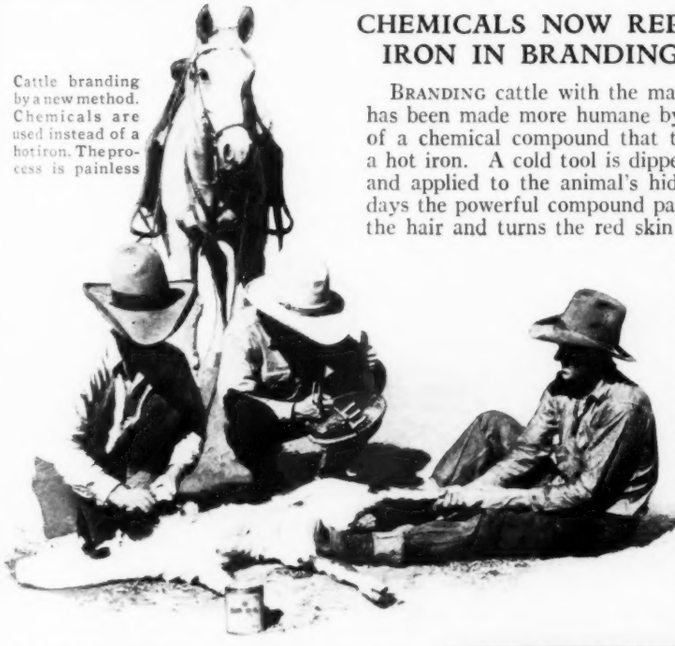




This big truck and its trailer ride the roads on twenty-four wheels like the two seen in front

TRUCK AND TRAILER HAVE 24 WHEELS

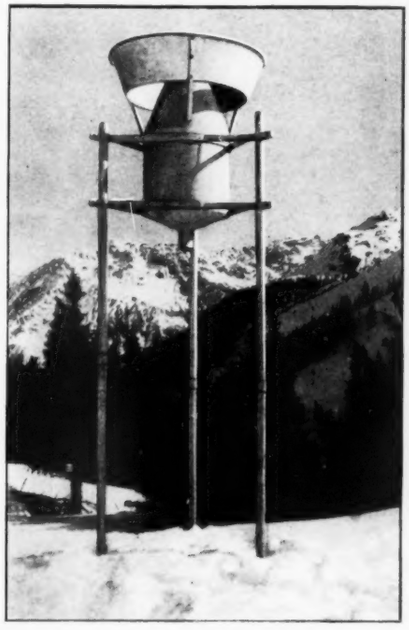
VIEWED from the front, a new truck introduced by a British manufacturer, appears to be all wheels. Twenty-four, in all, support the truck itself and the two trailer sections with which it is furnished, enabling the remarkable vehicle to maneuver with ease over rough and seldom-traveled routes. Two spare wheels carried at the front of the machine enhance its grotesque appearance. The truck is powered with a motor that operates upon oil fuel and develops 130 horsepower.



Cattle branding by a new method. Chemicals are used instead of a hot iron. The process is painless

CHEMICALS NOW REPLACE HOT IRON IN BRANDING CATTLE

BRANDING cattle with the mark of their owner has been made more humane by the introduction of a chemical compound that takes the place of a hot iron. A cold tool is dipped in the chemical and applied to the animal's hide. Within a few days the powerful compound painlessly eats away the hair and turns the red skin to white, leaving a permanent and indelible identification mark. Cowboys of the old-fashioned school, distrustful at first of the new method, have come to approve it because the animals, feeling no pain, are far easier to handle and the job is more expeditiously done.

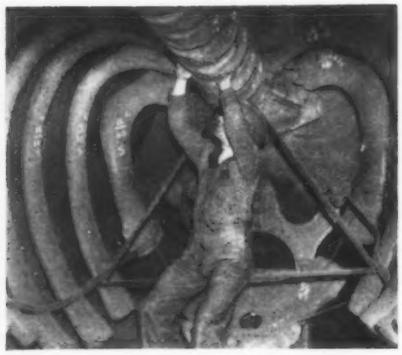


METAL COLLAR SUPPORTS CAR DRIVER'S HEAD

LONG-DISTANCE drives are made less arduous for the motorist, according to a Cincinnati, Ohio, inventor, by a shock-absorbing headrest that he has devised. A hinged metal collar lined with soft material snaps about the neck of the driver, supporting his chin and the back of his head upon his shoulders through spring arms. In addition, the inventor declares, his device makes a night driver less likely to be overcome by sleep.

METER ON STILTS GAGES RAIN ON MOUNTAIN TOP

SET high on stilts to clear the accumulation of drifts that might otherwise bury them, pot-shaped contrivances, like the one illustrated above, serve to measure the fall of rain and snow in the Swiss Alps. Every two months an observer makes the rounds on skis to note the precipitation that they record. The station shown in the photograph is situated more than 13,000 feet above sea level in the Alps Mountains.



MAN ENTERS WHALE TO TAKE IT TO PIECES

WHEN a giant whale was recently moved from its accustomed place in a British museum to a new location, an attendant was called upon to play the role of a modern Jonah. Entering the cavernous interior of the monster, as shown above, he aided in disassembling the massive bones of the skeleton from their mounting. Each of the bones was carefully numbered before removal. The task of moving one of these creatures is appreciated when it is realized that the head of a whale, alone, may weigh a ton.

MAPLE-SEED CHUTES DELIVER AIR MAIL

WATCHING the seeds of a maple tree spiral gently to earth, Kennet J. Girdwood, of Bethlehem, Pa., saw the possibility of copying these natural parachutes for practical use. In consequence, he has just received a patent upon a revolving parachute for dropping letters and small packages from speeding planes. Made of reinforced fabric, its design follows almost exactly the seed pod that furnished its inspiration. Places that have no landing field can receive their mail and supplies by means of these chutes, the inventor points out. The harder they are thrown into the air, the sooner they start to whirl, and they may therefore be dropped from low altitudes that would not give the standard type time to open.

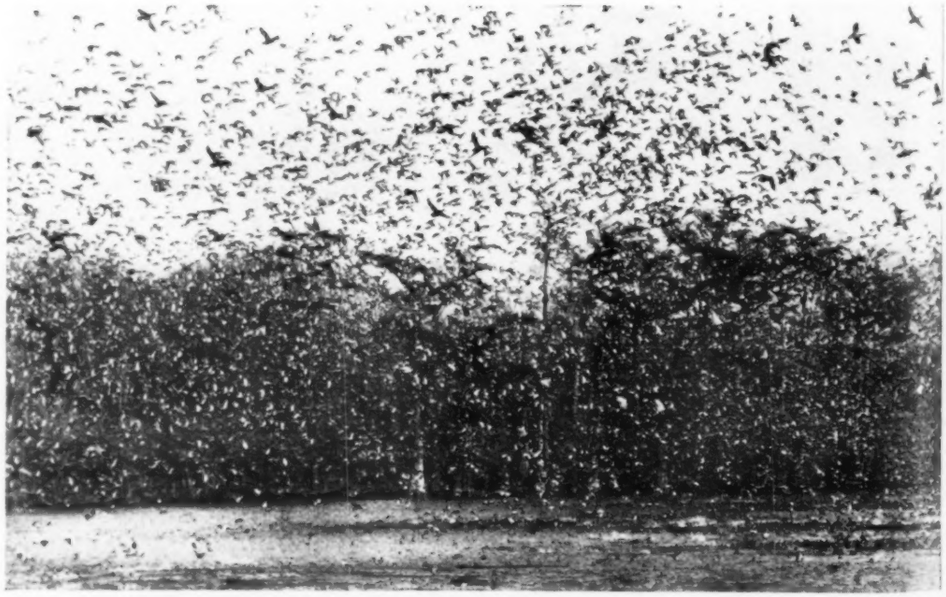
Above, whirling parachute, released from plane, carries mail safely to ground. At left, the inventor with his chute. Note compartment in lower end of chute for mail

USE AMERICA'S WORST ROAD TO TEST CARS

TO DETROIT, Mich., goes the dubious distinction of possessing what is called the worst road in America. Just completed by a motor car maker for testing new models, it appears innocent enough when viewed from a distance, as in the picture at left; but a ride upon it represents a motorist's nightmare. Slippery paving invites a skid, and made-to-order ruts and bumps pound tires and springs. When his latest machine has proved its worth on this road, the maker is reasonably sure that it will stand up on the public roads.

LAKE SHELTERS MILLION DUCKS

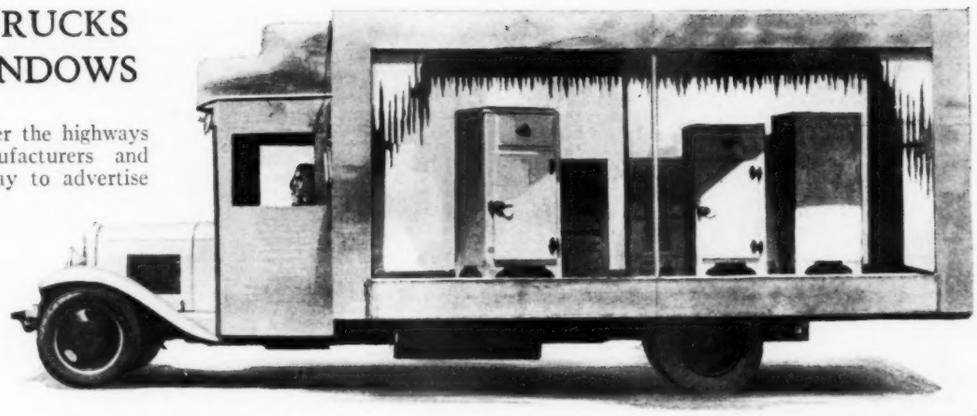
BLOTTING out the sun with their wings, wild ducks fill the air at a private sanctuary maintained by George H. Wilcox, Arkansas bird lover. More than a million, he estimates, visit a lake on his property near Stuttgart during the winter. The photographer snapped a goodly portion of them in the remarkable view reproduced at the right. Assisted by two aides, Wilcox patrols his preserve to keep hunters from molesting the birds that are enjoying his hospitality. A lookout tower affords him a point of vantage from which to study the habits of the flock, and occasionally to shoot down a menacing bird of prey. The picture was taken as the ducks rose from the lake.



A vast cloud of wild ducks caught by photographer as they rose from a private sanctuary in Arkansas

GLASS-SIDED TRUCKS REAL SHOW WINDOWS

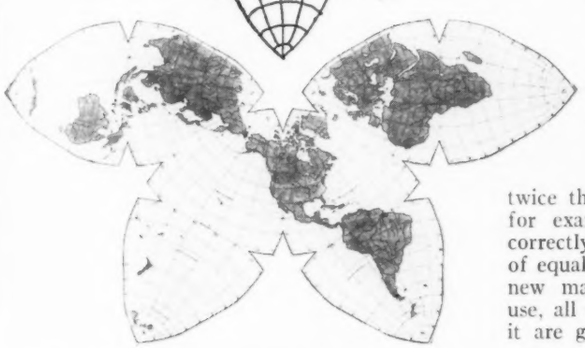
BY MOVING merchandise over the highways in glass-walled trucks, manufacturers and dealers have found a new way to advertise their products. The vehicles serve as show windows on wheels and draw the eyes of passers-by to their contents, which are attractively displayed. In some cases they are used to make deliveries to customers, or to transport merchandise between branch stores, while others are employed solely as traveling displays.



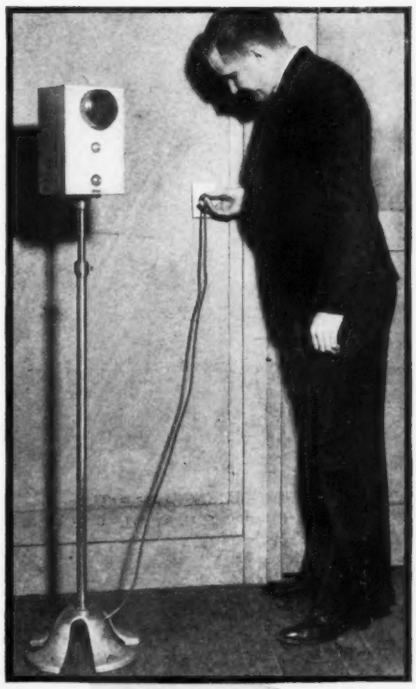
Glass sides on this truck give a clear view of its contents which are attractively arranged like a show window

BUTTERFLY MAP OF WORLD AIDS FLYERS

Below, the butterfly map which correctly represents areas and directions on surface of earth. Right, rubber ball slit as shown and pressed flat would resemble the butterfly map

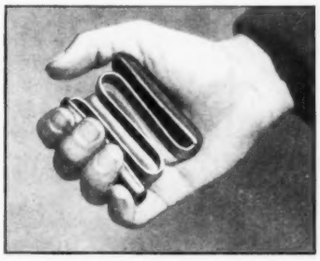


DRAWING a world map in the shape of a butterfly is the odd method purposed by B. J. S. Cahill, San Francisco architect, to represent the earth's true shape upon a flat surface. Newest of the many schemes devised by cartographers who have wrestled with this difficult problem, it is declared especially useful in charting world weather conditions and the routes of long-distance aviation flights because of its comparative lack of distortion. While common maps show North America as about twice the size of South America, for example, the butterfly map correctly portrays them as about of equal size. In one form of the new map prepared for aviation use, all straight lines drawn upon it are great circles of the globe.



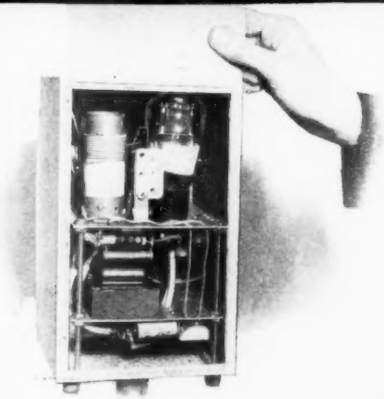
USE LOOPS OF SPRING METAL IN NEW HAND EXERCISER

BY BENDING a strip of spring metal into a series of loops, and attaching a pair of leather grips to the ends, a British inventor has produced a simple hand exerciser for golfers, tennis players, and musicians. When the user squeezes and relaxes the fingers of the hand holding the device, as shown at right, the muscles are said to be strengthened.



SNAILS NOW GROWN ON GERMAN FARM

A SNAIL farm not far from Berlin, Germany, lays claim to being the only place outside France where these land-going mollusks are raised for food. Bushels of the shell-covered creatures are shipped from this establishment to German and French markets, where they are considered a table delicacy. Because their wanderings cover an area surprisingly large, the snails on the German farm are confined by miniature wire fences like the one seen enclosing the field in the photograph at left.



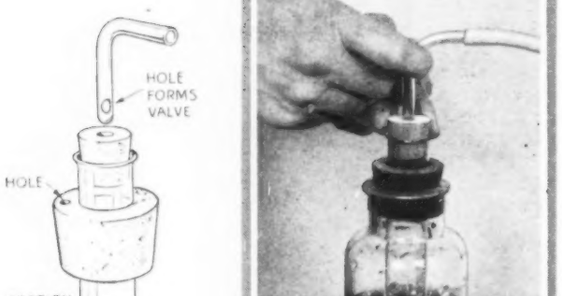
PUBLIC ADDRESS SYSTEM USES WALL SOCKETS

WHEN the transmitter of a new public address system is plugged into the nearest wall socket, as shown in the upper view, a standard radio receiver and loudspeaker connected to any other socket in the building will reproduce a speaker's voice. An amplifier within the microphone cabinet, shown in lower view, transmits the program over existing electric light wires, dispensing with trailing cables between microphone and loudspeaker.

Home Tests Reveal Strange Nature of Sulphur

To combine zinc dust and sulphur electrically, the powder is placed in the lid of a tin can, below, which is connected to one side of a dry-cell battery. When the second wire connection is scratched against the tin lid its spark sets off the mixture, which burns with a brilliant flame

By Raymond B. Wailes



This simple gas generator is useful in preparing small quantities of gas. It has a valve, as construction diagram, upper left, shows, that stops gas when flow is cut off

IT IS surprising what exciting and mystifying experiments can be performed with a few cents worth of sulphur.

Like oxygen, sulphur is a particularly active element. In fact, it combines with many substances so eagerly that intense light and heat accompany the reactions.

At high temperatures, sulphur combines with metals to form sulphides. To demonstrate this, the amateur chemist can place a small quantity of sulphur in an ordinary tin can and heat it with an alcohol or gas flame until it burns. If a wad of steel wool then is pushed into the can, the sulphur immediately will combine with the iron to form iron sulphide. In reacting, the mass will glow and crumble like a miniature volcano.

Zinc shavings or clippings, pieces of copper window screen, aluminum bronze, and other metals thrown into burning sulphur will react in a similar way to form metallic sulphides. The slag or sulphide that remains in each case should be removed from the can and placed in a labelled bottle for future use.

Mercury and sulphur can be made to combine simply by rubbing or grinding flowers of sulphur in a mortar with several drops of the liquid metal. Mercuric sulphide will result.

Zinc dust (finely divided zinc) and sulphur also will combine readily if the mixture is set off by an electric spark. The powder can be placed in the lid of a tin can connected to one side of a battery consisting of two or three dry cells arranged in series. The second wire from the battery should be thrust through the pile of zinc and sulphur until it comes in contact with the can. By scratching the wire on the can, it can be made to spark sufficiently to set off the mixture. A brilliant flame will result. Although the experiment is otherwise harmless, the home chemist should keep his hands at a safe distance from the flaming mixture.

Iron filings and sulphur can be made to combine without heat. Simply make a mixture of the two and rub it into a paste with water. In several hours, the mixture will become stone hard.

By taking advantage of the fact that iron and sulphur combine to form a black sulphide, the chemist can use sulphur to obtain a black finish on iron. First a physical solution of sulphur in warm turpentine should be made. This will furnish the sulphur in a convenient form for application to the surface of the iron. The iron objects then should be dipped into the solution and finally held in the flames of a gas or alcohol burner. To obtain an even lustrous coating, it may be necessary to repeat this dipping and heating process several times. When heating the turpentine to dissolve the sulphur, keep a square of asbestos board handy. It can be used to smother out the flames if the liquid suddenly takes fire.

In its ability to form evil-smelling compounds, sulphur has few rivals. Most common of these compounds is hydrogen sulphide (a poisonous gas), formed when a sulphide is brought in contact with an acid.

When small quantities of the gas are desired, the amateur can manufacture it with safety in the novel automatic gas generator shown. It consists simply of a wide-mouthed bottle supplied with a cork which is fitted with a length of large tubing. A test tube with a broken bottom will serve the purpose nicely. Fit the bottom of the tube with a perforated cork and place the solid reacting substance (iron sulphide in the case of hydrogen sulphide gas) inside the tube. The upper end of the tube should be closed with a cork or rubber stopper fitted with an L-shaped piece of glass tubing.

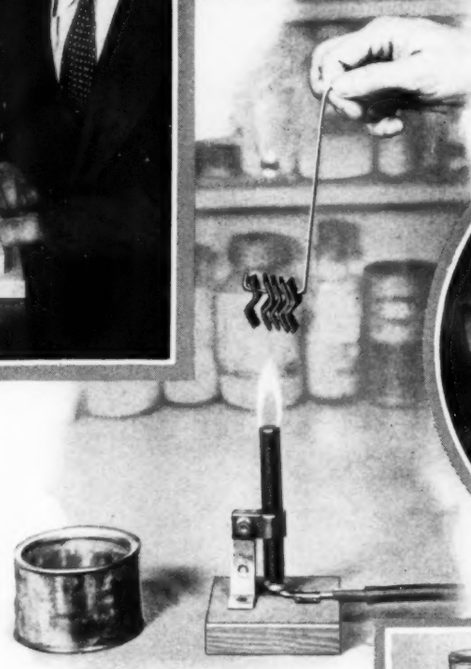
The lower end of the L-shaped exit tube should be closed and supplied with a small hole as shown. This can be done by heating the tube in a flame and allowing the end to melt and close over. The hole then can be prepared by holding the side of the tube in the flame until it is red hot and blowing into the other end of the tube to force the wall out. When the glass has thinned, pierce the hole, reheat the tube, and finally roll the hot tube on a sheet of asbestos to smooth the edges and avoid the formation of a lip. This hole must be smooth, as it is to serve as a valve for the generator.

When the tube is pushed down in the stopper exposing the hole, the acid in the bottle will rise in the test tube and react with the solid to form the gas. Pulling the tube up, shuts the valve by allowing the cork to cover the hole. This will prevent the gas from escaping and cause it to force the acid below the level of the solid. The reaction then will cease.

Invisible Inks, and Pictures That Will Change Colors Most Mysteriously, Can Be Made with Ease in Your Own Laboratory

In this experiment, sulphur is placed in a tin can and heated until it burns. Then steel wool is thrust into it. Combining instantly, they will glow like a volcano

Below, an uncolored picture painted with a metallic solution, several of which are given in the text. When the picture is exposed to hydrogen sulphide water, colors appear



Iron objects can be given a black finish by dipping them in a solution of sulphur and warm turpentine and then holding them in the gas flame

In case of hydrogen sulphide, the acid can be one part of sulphuric or muriatic diluted with three or four parts of water (by volume).

If hydrogen sulphide gas is allowed to bubble through water, a weak acid, known as hydrogen sulphide water or hydrosulphuric acid, is formed. It should be stored in a well-stoppered bottle to preserve it. In time, it will turn milky in appearance owing to the gradual precipitation of the free sulphur.

Such a solution can be used as the basis of some interesting color experiments with metallic solutions. Added to copper sulphate, for instance, a black sulphide is formed. Mixed with iron solutions such as ferric ammonium sulphate, black iron sulphide will be produced. Mercury solutions give a black precipitate of sulphide of mercury; antimony, bismuth, and tin solutions give orange, light brown, and brownish-black precipitates respectively; while cadmium solutions produce yellow cadmium sulphide.

To produce the colored precipitates formed by the antimony, bismuth, and tin solutions, it will be necessary to add a drop or two of muriatic acid after mixing the crystals with water. This will cause them to dissolve to give a clear solution.

This color-forming characteristic of hydrogen sulphide and metals can be used to perform an interesting and mystifying experiment. An uncolored picture or scene can be painted with the chemical solutions suggested above. When applied, they will appear colorless but on exposure to a wad of cotton dipped in hydrogen sulphide water they will become mysteriously colored. For instance, the little girl's dress in the picture shown was painted with colorless antimony chloride solution. When the hydrogen-sulphide-soaked cotton was wafted near the paper, however, it turned orange.

A variation of the same reactions can be used in making invisible ink for secret writing. Writing penned with a lead acetate or a ferric ammonium sulphide solution will be invisible. It can be developed and made visible, however, with hydrogen sulphide water.

Strange as it may seem, small amounts of hydrogen sulphide and other sulphur compounds usually are present in the air. In fact, it is their presence that causes articles of silver to become tarnished when left exposed. The tarnish in reality is a coating of silver sulphide.

To prevent the formation of this coating, place lumps of camphor in close contact with the metal; in the drawer or cabinet where the silver is stored. The camphor will sublime on the silver and form a protective coating that will prevent the sulphurous air from reaching the metal.

Lead paints become discolored for the same reason. In this case, however, the product that causes the discoloration is lead sulphide. However, the fact that lead sulphide can be oxidized to lead sulphate, which is white, makes it possible to treat discolored painted surfaces. A solution of hydrogen peroxide washed over the blackened paint, often will restore its color.

If acid bottles are fitted with cap and cup as shown, the acid is shielded from dust and your table is protected from injury. Cap and cup are cut from the bottoms of bottles of right size

You can prove this experimentally by exposing a piece of white paper, dampened with lead acetate, to hydrogen sulphide gas or hydrogen sulphide water to form lead sulphide. Then swab the stained paper with some household peroxide. The nascent oxygen from the peroxide will bleach the color, changing the black lead sulphide into white lead sulphate.

Hydrogen sulphide gas can be made to react with hot lead peroxide to form white lead sulphate. The reaction is particularly interesting because it produces a brilliant light. The lead peroxide (brown oxide of lead) should be placed loosely in a glass tube and the hydrogen sulphide gas passed through the tube. Heat the tube containing the lead peroxide. This will start the reaction which will continue until all of the lead peroxide is changed to lead sulphate.

In this, as in other experiments with hydrogen sulphide gas, the unused gas issuing from the open end of the reaction tube must be passed into a bottle containing sodium hydroxide solution. This will effectively absorb the surplus and prevent it from *(Continued on page 109)*

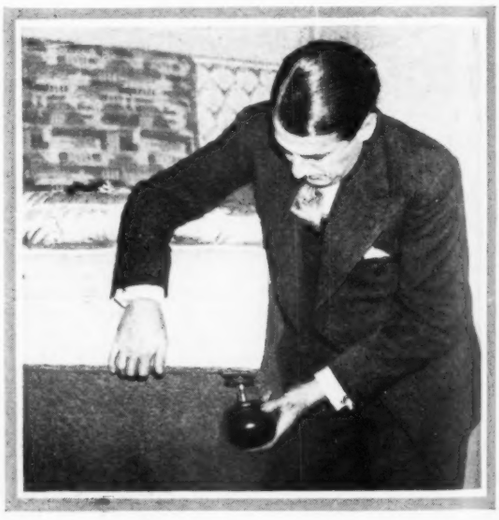
Useful Inventions FOR THE

DINING TABLE AND SHELVES IN ONE

When the set of shelves, shown at left, is rocked over on its pivot, it becomes a dining room table which can be moved on its own casters. Shelves are so arranged they remain horizontal in all positions so dishes are safe

STRAINER IN THIS SAUCE PAN COVER

The cover of this sauce pan contains a strainer through which liquids may be poured. The inner rim carries a series of slots, as shown in illustration at the right. Merely tipping the pan permits the liquid to drain out

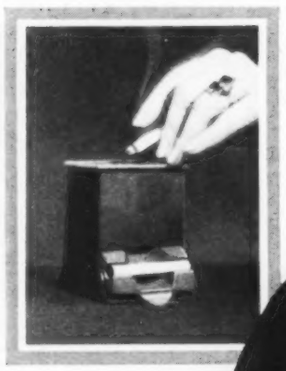


DETACHABLE DIVAN LEGS

Easily attached and removed, the divan legs, right, simplify the problem of moving heavy furniture without damage. They also make possible a change in type of legs if desired at various times

BOX SERVES CIGARETTE

When the box shown at right is tipped it serves a cigarette. The last one in the box, however, is retained as a warning the box is nearly empty. It will hold about thirty cigarettes



SHOPPING CART. A recent innovation in this country is the shopping cart illustrated above. The shopper pushes the cart from counter to counter selecting her goods and finally checks it at the packaging department

CREAM SEPARATOR. It is easy to separate the cream from the milk in a bottle with this device. The short end of the tube is inserted in the rubber cap which is placed over bottle. Pressure forces the cream out

RUBBER FURNITURE CUSHIONS. Whipped into a froth, rubber is poured into waffle-like molds and shaped to fit the inside of furniture cushions. Said to be insect-proof

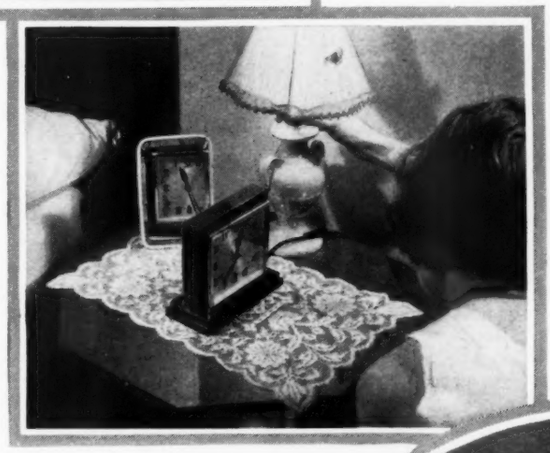
Household

NOISELESS KITCHEN UTENSILS. Housewives who suffer from noise in their kitchens will appreciate a set of utensils made of rubber, some of which are shown at left. They include strainer, scraper, dustpan, and sink rack. They will not scratch the sink or nick dishes

ICE TRAYS CAN'T STICK

If the grids, right, are slipped under ice trays when they are replaced, they cannot freeze to the rack. To remove them, they are simply lifted and drawn out. Device is designed for metal and rubber trays

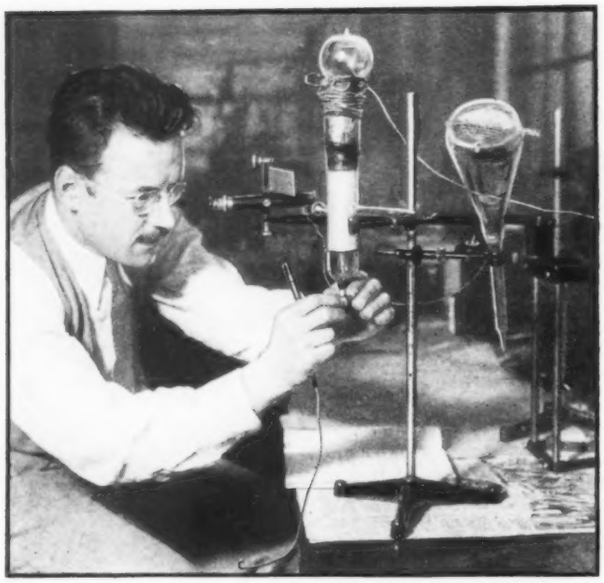
FOOD WARMER. The electrically heated plate, above, keeps food warm after it has been placed on the table. It is attractive in appearance and designed to harmonize with table decorations. Little current is used by it

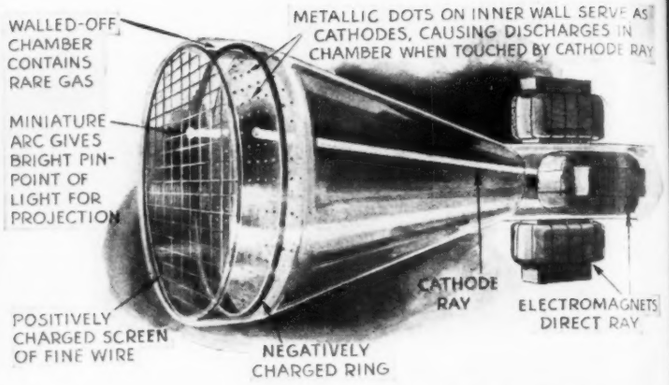


STOPS MILK THIEF. Pilferers of milk bottles are stopped by the ingenious apparatus shown below. Effort to remove bottle from outside rings alarm and releases a clamp that catches thief

TWIN BED CLOCK. Designed especially for a bedroom containing twin beds, the electric clock, shown at left, has two faces as may be seen in the mirror reflection in the illustration

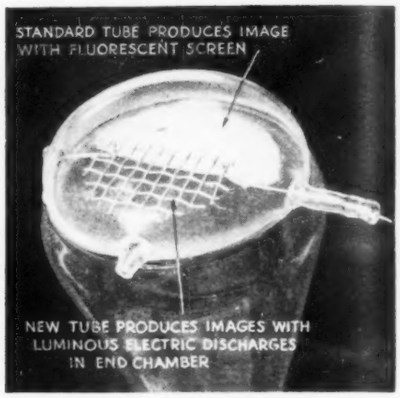
MODERN FIREPLACE. Apartments that have no chimneys can still use the fireplace shown below. Instead of a grate, it has an electric heater. Set close against the wall, it has an appearance that resembles a hearth




WALLED-OFF CHAMBER CONTAINS RARE GAS
MINIATURE ARC GIVES BRIGHT PIN-POINT OF LIGHT FOR PROJECTION
METALLIC DOTS ON INNER WALL SERVE AS CATHODES, CAUSING DISCHARGES IN CHAMBER WHEN TOUCHED BY CATHODE RAY
CATHODE RAY
ELECTROMAGNETS DIRECT RAY
POSITIVELY CHARGED SCREEN OF FINE WIRE
NEGATIVELY CHARGED RING

Left, Gilbert F. Schmidling, inventor of new cathode-ray tube for television, is seen with two of the experimental models built to test his design. Above, diagram showing principle of new system

Myriad Dots of Light Give New Television


STANDARD TUBE PRODUCES IMAGE WITH FLUORESCENT SCREEN
NEW TUBE PRODUCES IMAGES WITH LUMINOUS ELECTRIC DISCHARGES IN END CHAMBER

Close-up of combination window in model of new tube, built to contrast the brightness of projected image of the old and new types

MYRIADS of tiny twinkling electric arcs build up a picture on a screen, in a new type of television receiver now under experimental development for home and theater use. Described for the first time in this magazine, it aims to produce an image brilliant enough to be projected upon a screen of virtually unlimited dimensions, for parlor or public entertainment. Moreover, this is to be done without the complication of the moving parts that characterize most present-day television sets. The secret of the new receiver, developed in an effort to provide practical television for the man in the street, is a cathode-ray tube that departs boldly from conventional lines.

When a television broadcast transmitter dissects the image of a studio scene and translates its high lights and shadows into a rapid-fire series of radio impulses, the problem at the receiving end is to reconvert these impulses into light and put them together again in the form of a picture. Of the many devices contrived to do this, the cathode-ray tube has always particularly attracted experimenters because of its freedom from moving parts. In the standard funnel-shaped form of this tube, a speeding beam of electrons constantly sweeps a circular window at the wide end, which is coated with fluorescent chemicals. Wherever the beam strikes the window, the chemicals glow. By directing the beam magnetically, and controlling its intensity by means of incoming radio signals from the distant transmitter, it is made to redraw the studio scene upon the glass wall of the tube. One drawback, however, has limited the usefulness of this system. The resulting image is too dim to be magnified to an appreciable size, and must therefore be viewed directly in a window a few inches in diameter.

Seeking a cathode-ray tube with an image brilliant enough for projection, Gilbert T. Schmidling, New York radio experimenter, tried out thousands of fluorescent materials without avail. His search yielded interesting by-products, including the cold lamp described last month in this magazine, but revealed nothing that combined, to his satisfaction, the two vital qualities of a television screen, high luminosity, and quick fade-out. Then he solved his problem by the remarkable expedient of discarding the fluorescent screen altogether. What he substituted in its place makes his cathode-ray tube one of the strangest of radio creations.

In design the new type resembles a standard cathode-ray tube minus its fluorescent screen, with a cylindrical extension of glass added at the large end. As shown in the accompanying diagram, this extension is a walled-off chamber containing three types of electrodes—a screen of fine wire, a circular ring, and a pattern of thousands of metallic dots printed on the inner wall. The chamber is filled with a rare gas such as neon.

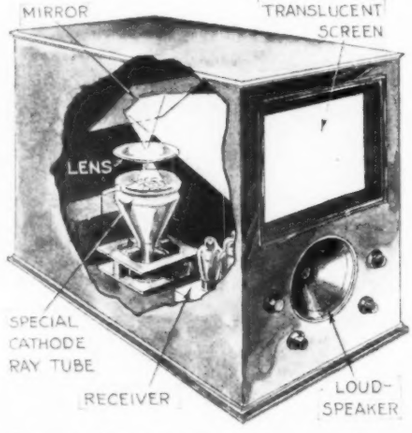


Diagram shows construction of proposed home television set, which produces a large image

When the moving cathode ray, or electron beam, passes over one of the metallic dots, it acts like a trigger to set off an electric discharge between electrodes in the auxiliary chamber. The luminous discharge resembles that of the neon crater lamps used in other television systems. Thus pin-points of light, opposite the dots that receive the full intensity of the moving ray, merge to form a brilliant image that with a suitable lens can be thrown on a screen. The wire-screen electrode between the original image and the observer does not obstruct his view of the picture, since the fine wires are thrown out of focus and rendered invisible in projection.

For home television, a tube with a window about four inches in diameter would be used. Its pictures would be thrown from the rear upon a translucent screen approximately eighteen inches in diameter. According to Schmidling, the images would be bright enough for onlookers to see them without the inconvenience of turning off the living-room lights. Larger tubes would throw television pictures on theater screens.

As early as 1927, Schmidling told POPULAR SCIENCE MONTHLY, he tested his invention with a crude model, building another of more elaborate design the following year. These two models, illustrated at left and right respectively in the photograph at the top of this page, demonstrated to his satisfaction that his theory was sound. Improved tubes developed in more recent tests, he believes, have paved the way for commercial application of the new system.

New Battery for Two-Volt Set

REVOLUTIONARY METHOD OF CONSTRUCTION CUTS COST TO ONE CENT AN HOUR

DESIGNED to operate for 400 hours at less than one cent an hour, the battery, shown in the illustrations at right, forms a new type of filament supply for two-volt receivers.

Resembling a large size B battery in outward appearance, this fifteen-pound dry unit is rigidly constructed and supplied in a sturdy case. Embodying what the manufacturers term a revolutionary method of construction, this recently developed battery is said to operate with a minimum of current drain.

Although primarily a three-volt battery, it serves as a two-volt source through the use of a novel resistor resembling a miniature voltage divider. The strip, connected to the positive terminal of the battery, is a wire-wound resistor having four easily operated clips spaced at intervals along its length. When the battery is first put into use, the clip at the extreme end is used. The other clips are used in succession as the voltage of the battery drops. In this way, it is possible to maintain the supply voltage at exactly two volts throughout the life of the battery.

At top, connecting up the new type A battery. In circle, close-up of battery's resistance strip

Emergency Repair of Audio Transformer

WHEN an audio transformer in a receiver goes dead, it is difficult sometimes to obtain a replacement. However, the radio handy man can make an emergency repair by changing that particular amplifier stage from transformer coupling to impedance or resistance coupling.

First of all, you must determine which winding of the transformer is at fault. This can be done by making a simple continuity test with a pair of earphones and a small battery (C battery will do). Connect the phones and battery in series, wire the free terminal of the battery to one side of the winding to be tested, and touch the unconnected phone tip to the other side of the same winding. If the winding is continuous and not broken, you will hear a sharp click in the phones everytime the contact is made or broken.

If you find that the primary winding, for example, is broken, the receiver can be made to operate by connecting a 100,000 ohm resistor (A) across the winding and a .01 microfarad condenser (C) across the plate (P) and grid (G) terminals of the transformer. If the secondary proves to be at fault, connect a 500,000 ohm resistor (B) across the secondary, also shorting the plate and grid terminals with the .01 microfarad condenser (C). In either case, the addition of the condenser and resistor will convert the original transformer-coupled stage into an impedance-coupled circuit.

Although the chances are against it, you may find that both windings on the transformer are broken. In this case, connect the resistors specified (A and B) across their respective windings and short the grid and plate terminals with the condenser (C). This will change the circuit into a resistance-coupled stage.

Incidentally, the resistors can be smaller than those specified, but in any case the secondary resistor should be at least four times larger than the resistor shorting the primary. Also, the primary resistor should not be smaller than 50,000 ohms.

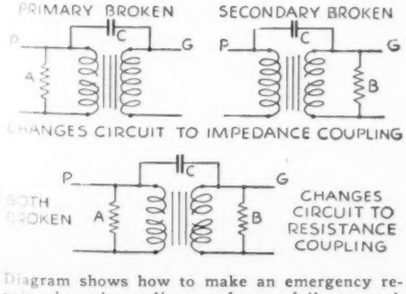


Diagram shows how to make an emergency repair when the audio transformer fails to work

Naturally, a repair of this type is a makeshift at best but where a slight decrease in volume will not effect the reception, it forms an excellent emergency repair.—L. K.

Pilot Lights Detect Transmitter Trouble

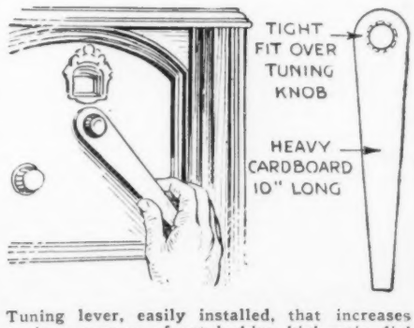
BY PLACING a small coil of wire in series with a regular one-and one-half-volt flash-light lamp, you can provide your short-wave transmitter with a simple pilot light. The coil, containing two or three turns of wire, can be placed close to the plate end of an oscillator or amplifier circuit. When the power is on, the wire will pick up enough current to light the bulb and tell you that the circuit is operating. If desired, a pilot light of this type can be placed in each stage of a multi-stage transmitter. The bulbs can be mounted behind lens-shaped pieces of red glass inserted in the face of the transmitter panel above the controls.—G. D. T.

Novel Short-Wave Tuning Lever

BECAUSE they lack high-ratio tuning dials, many of the new radios built to cover the short-wave bands present a difficult problem in tuning. With the small knobs used, it is an easy matter to pass completely over the desired station without hearing it.

A solution to this problem, however, is found in the novel tuning lever shown in the illustration below. It will improve the tuning accuracy of a small knob more than sixteen times by increasing the effective diameter of the knob.

Cardboard, one sixteenth of an inch thick, will serve as suitable material for the lever. The hole to receive the knob should be made one eighth of an inch smaller than the actual diameter of the knob. Then, a series of one-sixteenth-inch cuts should be made radially around the opening and the flaps formed should be bent back. The purpose of these flaps is to provide the tension required to hold the lever firmly on the knob.—A. W. A.

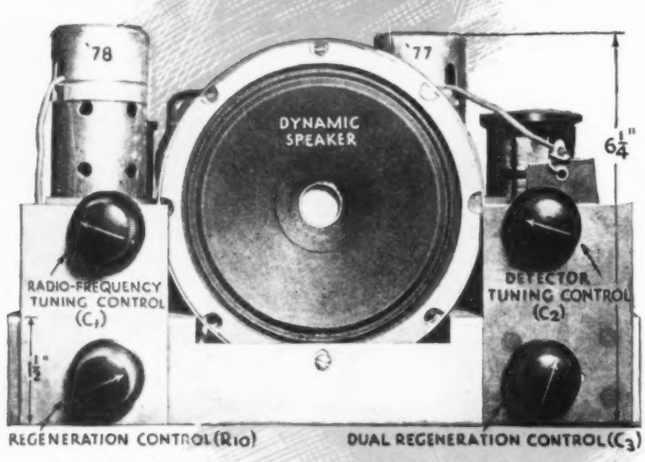


Tuning lever, easily installed, that increases tuning accuracy of set lacking high-ratio dial

Short-Wave

LEWIS WINNER *tells how to*

Although designed primarily as a short-wave receiver, this midget set can be used on the broadcast band also. It operates on either alternating or direct current



Front view of the portable set's chassis, showing the midget dynamic speaker and the four controls which are already arranged in place

THERE is no need to give up your short-wave hobby when you are away from home. The midget, eight-pound receiver illustrated operates on direct as well as alternating current and will give you clear, loudspeaker reception wherever 110 volts are available.

In appearance, the outfit resembles the tiny broadcast sets that have gained widespread popularity during the last year. In fact, it was designed to fit into a regular midget cabinet that was obtained for next to nothing from a dealer in second-hand radios.

The circuit is simplicity itself. It consists of one stage of radio-frequency amplification, a regenerative detector, and two stages of resistance-coupled amplification fed by a novel A.C.-D.C. power supply. The tubes used are types 25Z5, '43, '37, '77, and '78.

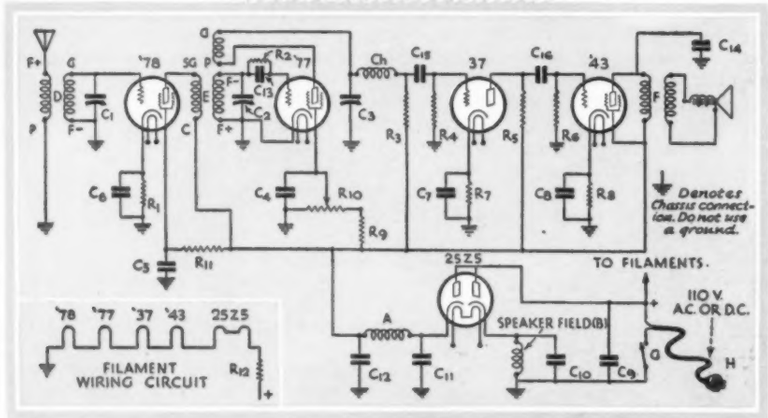
Complete, cabinet, tubes, and all, the set should not cost you much over twenty dollars, provided, of course, you wind the coils yourself. Because of the A.C.-D.C. power supply and resistance-coupled amplifier used, no transformers are needed. Also, inexpensive condensers can be used without reducing the efficiency to any great extent.

Like the commercial compact broadcast receivers, this short-wave set also is mounted on a miniature channel-shaped chassis. The midget dynamic speaker, having a five-inch diameter cone, is mounted in a groove or slot in the front of the chassis and is held in place with one screw passed through the bottom mounting hole in the outer rim and two through the chassis. Two rectangles of sheet metal spot-welded or bolted to the front of the chassis at both ends serve to support the two tuning condensers (C_1 and C_2).

Seven wafer sockets are arranged on the top face of the chassis as shown in the photograph. Two, a four-prong and a six-prong, are for the plug-in coils. These are placed at the extreme ends, at the rear, so the coils can be changed easily. The other sockets required are a five-prong for the '37 tube and four of the six-prong type for the 25Z5, the '43, the '77, and the '78. Also mounted on the top of the chassis are the filter choke A and the filament resistor R_{12}.

Although the circuit was designed primarily to cover the short-wave bands from fifteen to 200 meters with four sets of plug-in coils, the range can be extended satisfactorily to cover the broadcast band (200 to 550 meters) by using an additional broadcast coil. This coil is designated as number five in the winding table. However, because of its fundamental design, the circuit may prove less selective on the broadcast band than it is on the shorter waves.

In studying the circuit diagram you will note that various connections are indicated as being made to ground. In every case, this denotes a chassis connection. These can be soldered directly to the chassis or to a brass soldering strip bolted to the inside of the chassis.



Wiring diagram of circuit, the specifications of which are given in table on opposite page. Note, the filament wiring is shown in diagram in the lower left hand corner

Blueprints Ready

To assist readers in building this compact electric set, an easily followed blueprint has been prepared. It can be obtained by sending twenty-five cents to the Popular Science Blueprint Service Department, 381 Fourth Avenue, New York, N. Y. for Blueprint No. 223.

Receiver *TO TAKE WITH YOU ON TRIPS*

build this compact radio set

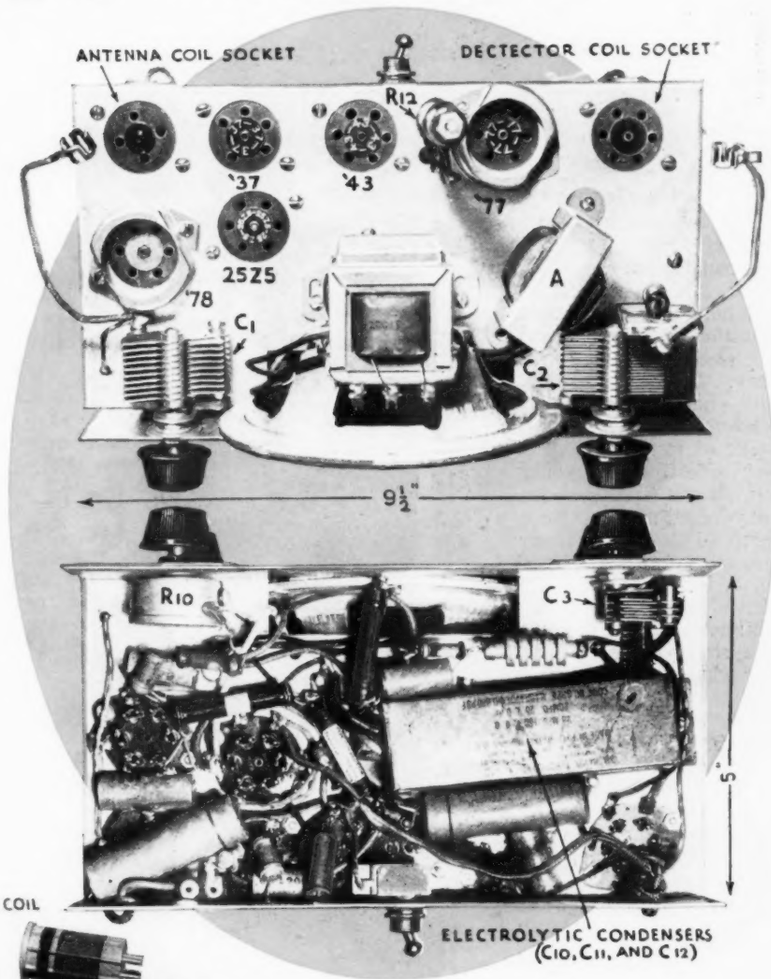
No actual connection to the ground should be made. The circuit requires only a long (75 to 100 feet), well-insulated antenna. If there is any doubt about the insulation of the antenna, place a .0001 microfarad fixed condenser in the antenna lead close to the set. In fact, this is a wise precaution even if the antenna is well insulated as it will protect the set should the antenna become accidentally grounded.

In changing the circuit for reception of the various bands, a set of two plug-in coils is required for each band. One coil, having a four-prong base, is the antenna coil while the other, fitted with a six-prong base, is the detector coil. The antenna coils have only two windings, a primary and a secondary, but the detector coils have three, a primary, a secondary, and a tickler. How these are placed on the ribbed coil forms is shown in the drawings. In the case of the short-wave detector coil, the primary is interwound with the secondary. On the broadcast detector coil, however, where the wire of the secondary is not spaced, it can be wound over the secondary.

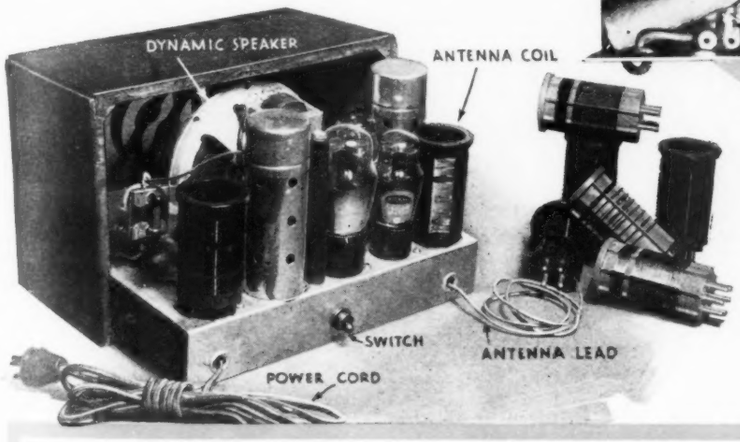
Although these coil sets can be purchased ready for use, you will save money by buying only the ribbed forms and winding them with enameled wire according to the specifications given in the box on this page (below). Be sure when making the connections to the coil base prongs that you follow the exact arrangement shown so they will agree with the socket connections.

Because of the amount of drilling necessary, it will pay the amateur to buy his chassis ready-made from a dealer in radio parts who is equipped to do the work reasonably.

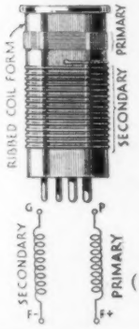
When laying out the chassis, allow for the fact that the '77 and '78 must be fitted with tube shields, bases, and caps. Two holes should be supplied at the rear of the chassis—one for the power cord and the other for the antenna lead. The power switch also is mounted at the *(Continued on page 114)*



View at the top shows the layout of sockets on chassis. Other view shows wiring under the chassis

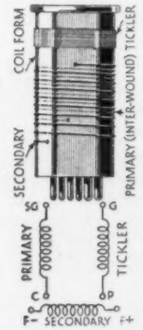


ANTENNA COIL SPECIFICATIONS



	PRIMARY Close Wound	SECONDARY Spaced to 1½ in.
15 to 35 meters	6 turns No. 24	7 turns No. 16
35 to 60 meters	9 turns No. 24	13 turns No. 16
60 to 90 meters	12 turns No. 24	21 turns No. 16
90 to 200 meters	20 turns No. 28	47 turns No. 24
200 to 550 meters (Broadcast, optional)	20 turns No. 36	145 turns No. 36

DETECTOR COIL SPECIFICATIONS



	PRIMARY Inter-wound with secondary	SECONDARY Spaced to 1½ in.	TICKLER Close wound
15 to 35 meters	3 turns No. 24	7 turns No. 16	6 turns No. 24
35 to 60 meters	7 turns No. 24	13 turns No. 16	9 turns No. 24
60 to 90 meters	15 turns No. 24	22 turns No. 16	12 turns No. 24
90 to 200 meters	32 turns No. 28	45 turns No. 24	20 turns No. 28
200 to 550 meters	20 turns No. 34	145 turns No. 34	34 turns No. 34

Broadcast coils are close wound

Hunting Your Car's Caster

By MARTIN BUNN

Gus Gives a Practical Lesson in Adjusting the Front Wheels

GUS WILSON'S annual visit to his upstate relatives had a way of developing into a busman's holiday.

On this particular trip, his hopes for a workless vacation were shattered the second morning of his stay. This time it was Bill, his eldest nephew, who upset his plans for a week of rest.

"Uncle Gus," the young man began timidly as the gray-haired auto mechanic propped his morning paper against the sugar bowl and leisurely poured himself a second cup of coffee, "will you show me how to check the steering gear on my car while you're here?"

"What seems to be wrong?" asked Gus good-naturedly.

"The car keeps running to the right," explained Bill. "I have to wrestle with the steering wheel to keep it on the road."

A grunt was Gus's only answer as he followed his nephew to the front curb where the car was parked.

"First of all, we'll have to find a good place to work," said Gus after a hasty inspection. "How about running the front wheels onto the driveway outside your garage? While I move the car around there, you go to your Dad's workshop and see if you can hunt up a couple of lengths of wood lathing, a hammer, a saw, some nails, and a large steel square. And, say, if you can find one of those adjustable spirit levels bring that along too."

Gus finished parking the car just as Bill, his arms laden, emerged from the cellar door.

"What are you going to do with all this stuff, Uncle Gus?" asked Bill as he piled the tools and lumber on the car's running board. "All I want to know is how to check the steering gear."

"I don't think the steering gear has much to do with your trouble," replied Gus as he picked up the two long sticks and sighted along the first one and then the other. "Sounds like unequal caster."

"Unequal what?" asked Bill.

"Caster," repeated Gus. "Don't you know what that is?"

"No relation to the oil, is it?" grinned Bill.

Gus shook his head. "Nope, it's an angle and it's one of three important front-wheel adjustments. There's camber, toe-in, and caster."

"Caster is an angle," Gus explained, "and it's one of the three important front-wheel adjustments. There's camber, toe-in, and caster"

The puzzled look on Bill's face told Gus that the subject needed some tall explaining.

"Here, take a look at this," said Gus as he wheeled out a bicycle that had been leaning against the garage wall. "Do you notice how the steering pivot for that front wheel is back of the wheel's center. Well, that's caster. It's just like the arrangement of the casters on furniture legs. The front wheels of an automobile are pivoted in just the same way. The king pin on each wheel is tilted by the axle to give the caster angle.

"Now, if this bicycle wheel is tilted a little off the vertical," Gus continued as he held the bicycle at an angle, "that illustrates camber. The front wheels of a car are tilted just like that. They're mounted to be closer together at the bottom than they are at the top.

"As for toe-in, that's just what you'd expect from the name," continued Gus. "The front wheels are pigeon-toed; their front edges are closer together than their rear edges."

"How the dickens can two wheels be like that all at once? Seems like they'd get all mixed up," argued Bill. "As far as I can see, camber and toe-in are pretty much the same thing, except one is horizontal and the other is vertical."

"Right," agreed Gus, "and if either the caster or the camber are wrong, they'll upset the toe-in. That's why toe-in is a check on them all. If the toe-in measures O. K., you can be pretty sure that the camber and caster are right."

"Sounds like an awful lot of measuring to me," observed Bill. "How would you check all those angles?"

"Well, the best way is to use regular measuring instruments that are made for the work. All good repair shops and service stations have them. Of course, in a case like this, you can put together some tools that will do a good enough job.

"For instance, camber tilts the front wheels out at the top, like this," Gus explained, indicating the angle with his hands. "Well, we can check that by placing a large steel square flush against the hub and measuring the distances between the rim and the vertical edge of the square at the top and at the bottom of the wheel. If the *(Continued on page 115)*

WHAT AILED STEFFINS' CAR?

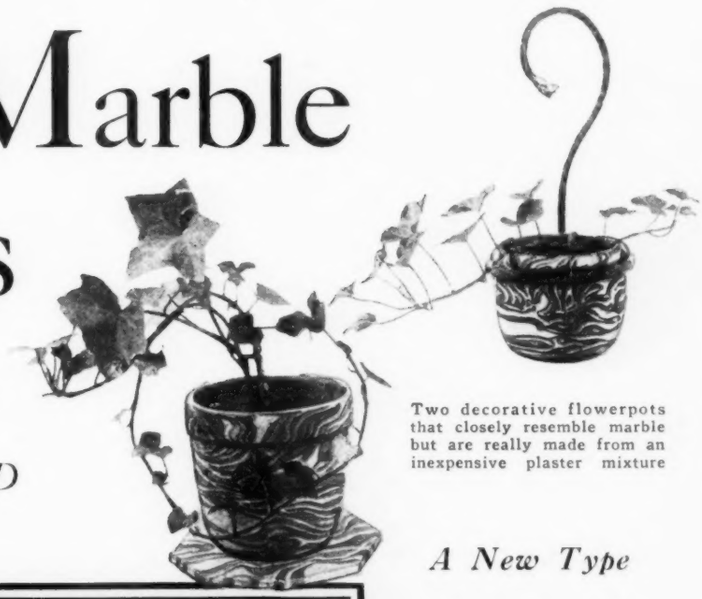
Announcing the Prize Winner

IN the January issue of POPULAR SCIENCE MONTHLY, Martin Bunn described the troubles Fred Steffins, one of Gus Wilson's customers, was having with his car. A prize of twenty-five dollars was offered for the best letter explaining the difficulty and telling how it could be remedied.

Many readers submitted solutions, a large number stating correctly that a worn timing chain or a slipping fiber timing gear was the cause of the trouble. In the opinion of the judges, Richard F. Lawson, Detroit, Mich., wrote the best letter diagnosing the trouble and describing the remedy and Mr. Lawson was awarded the prize.

Artificial Marble Novelties

TURNED IN LATHE LIKE WOOD



Two decorative flowerpots that closely resemble marble but are really made from an inexpensive plaster mixture

A New Type of Craftwork That Is Easy to Do and Costs Next to Nothing for Materials

By E.G. Livingston

Assistant Professor of Industrial Arts, Iowa State College

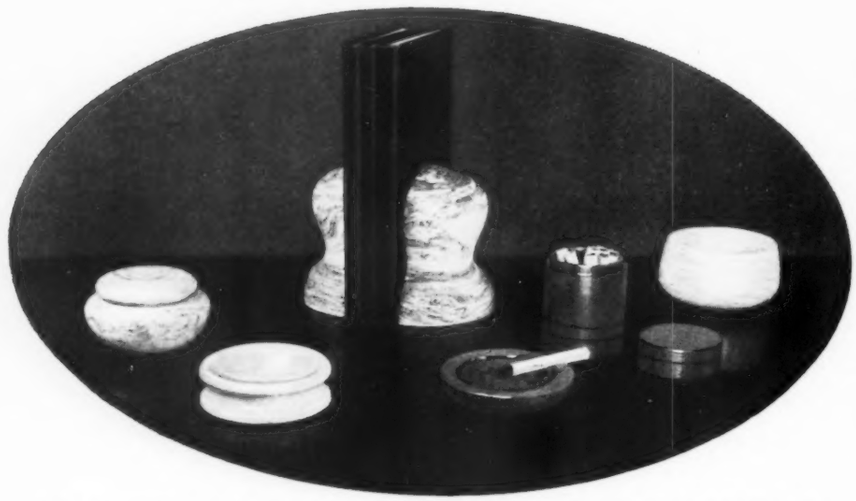
COLORS GIVE MARBLE EFFECT

The special cement is mixed with water in such a way as not to stir in too much air. Then dry limeproof plaster colors are added to produce a pattern that looks like marble

IF YOU are looking for something really new to make in your home workshop or at school, you should experiment with turning artificial marble. This fascinating handicraft has many advantages. An important one is that the material is quite inexpensive and is obtainable everywhere. You can have the fun of making a number of things at the cost of only a few cents. In spite of their low cost, however, the finished articles are useful, novel, and beautiful. They never fail to elicit the admiration of all who see them.

Even the most inexperienced amateur can achieve success with the more simple forms, yet the most skillful worker will find a challenge to his liking. The possibilities in both design and craftmanship are practically unlimited. If you have a lathe and a few common hand tools, you need no other equipment. Finally, but not of least importance, the articles have sales value. Any man of skillful and ingenious bent may turn his pastime into ready pocket money.

If you would like to try your hand at making some of the attractive pieces illustrated, the first step is to go to any lumber dealer or building supplies firm and purchase about ten pounds of Keene's cement. The superfine grade is best, but



A few examples of artificial marble work. The book ends were turned in one piece, then cut in half with a hand saw. The cigarette holder has a copper lining around which the marble mixture was cast before any turning was done. Each piece is beautifully colored

the regular grade is very nearly as good and is less expensive. Ten pounds should cost about twenty-five cents. At the same place buy about a quarter of a pound each of two or more limeproof plaster colors. These are mineral colors in powder form and may be had in a variety of hues. Do not buy cement colors.

It is wise to select a simple piece for your first attempt. A pin or paper-clip tray or an ash tray is suitable.

To make a form in which to cast the cement, cut a circle about 3½ in. in diameter from any scrap wood from ¼ to ¾ in. in thickness. Attach it to a lathe faceplate, using screws that are long enough to extend about ⅜ in. through the wood for the purpose of holding the cement. Place the faceplate on the lathe and true up the wood. The wood should now be given two or three coats of lacquer to make it impervious to moisture. If you do not have lacquer, however, use hot paraffin, paint, varnish, oil, or shellac.

The cast for the pin tray need not be more than 1 in. thick. Cut a piece of light galvanized iron long enough to encircle the wooden disk with about a ½-in. lap. The width should be 1 in. plus the thickness of the wooden base. Attach this to the periphery of the disk with three roundhead screws to form a shallow cup. Lacking galvanized iron, you may use tin or even cardboard.

MELT some paraffin and add an equal amount of kerosene. When this is cool it will be about the consistency of paste shoe polish. Coat the inside of the form with this "dope." Of course, linseed oil or machine oil will serve the same purpose.

For mixing the Keene's cement, you will need a shallow granite pan or a mixing bowl, a large granite or a heavily tinned spoon, and a cup for water. Putty knives or even old case knives are convenient for handling the colors. The cement needed to fill the form and the required amount of water are easily determined by a little experimenting. Roughly, the amount of cement by volume will be a quarter more than the amount of dry cement required to fill the form, and the amount of water will be about one third of the volume of cement.

Place the cement in the pan, add the water, and mix it thoroughly for several minutes. Do the mixing quietly, keeping the spoon submerged in order to avoid stirring in too much air. Do not beat it. The consistency of the batch should be quite quakey, but hardly thin enough to pour.

To add the colors, simply take a little on the end of a putty knife and cut it into part of the batch. Take care that no lumps of dry color are unbroken. A different color may then be mixed into another part of the batch. The marbleized effect is obtained by stirring these colored areas together just a little or by mixing them as you fill the form. Many attractive color combinations may be worked out with a little experimenting.

IN THE process of filling the form, stop occasionally and bang it rather hard several times upon the bench top to jar out the air bubbles. When the form is full, cover the top with paper or a damp cloth to prevent excessive drying of the exposed surface. Put the cast away to set for from eighteen to twenty-four hours. It should be firm, but should cut easily when ready to turn.

Select a simple design for the pin tray and make a full-size drawing of it. Remove the metal or cardboard form from around the cast, and screw the faceplate on the lathe. Work as you do with wood, using the same tools or improvising tools from scrap steel or files. If the cement is at the right stage, not too hard, it can be cut with surprising ease and will not dull the tools as quickly as does wood. The cement cuts smoothly at a slow speed of about 1,200 R.P.M., and at that speed it is not apt to fly off the faceplate.

When the cutting is done, the piece should be removed from the faceplate and allowed to dry for another twenty-four hours. It is then polished with No. 6/0 or 8/0 sandpaper. If you attempt to sand it while damp, the colors will smear. If you can get No. 7/0 wet-or-dry (waterproof) sandpaper, it is better to polish the Keene's cement under water in a lavatory or large pan. Carborundum stones of fine grain may be used for polishing flat surfaces under water.

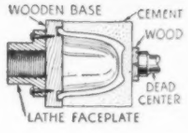
Special construction kits for making ship models and furniture will be found listed on pages 96 and 97.

By exercising ingenuity in building the forms, you may make larger articles such as candy or nut dishes, powder or jewelry boxes, cigarette containers, flowerpots, bulb trays, candlesticks, and table lamps. Several such articles and the forms used in their construction are illustrated in this article.

The little hanging ivy pot was made over a pyrex custard cup which had the rim set very tightly in a groove in the wooden base as shown in one of the photographs and a drawing. It is necessary to turn only the outside. When dry, the cement cup slips readily from the glass. Such a device makes it possible to save a great deal of time and a certain amount of material.

Flowerpots made of Keene's cement have one bad feature. They are not waterproof. Water not only seeps through them, but it causes a rough precipitate to gather on the surface. If you wish to set the plant directly in the pot, it should first be coated on the inside with liquid rubber. To avoid making a hole in the bottom of the pot, I place a false bottom of galvanized iron about ¼ in. from

A tray form; inner and outer forms for a small ivy pot; and, right, how the ivy pot was set up in a lathe to be turned



the bottom. The false bottom is punched full of holes, and extending from it there is a small tube reaching above the surface of the dirt. This serves to carry water and air to the roots and makes for a generally healthy plant condition.

The form for the cigarette holder was prepared in a similar way. A small cylinder, closed at one end, was made of copper and used as an inside form like the custard cup except that it was not removed, but became a copper lining in the cigarette jar.

The book ends were turned as one piece and sawed in two with a hand saw while still soft. The resulting rough surfaces were ground down with a sharpening stone under water. They were sanded again with very fine paper when thoroughly dry.

By the simple expedient of making a form 4 or 5 in. deep, several ash trays or pin trays may be made from one casting. They are turned one at a time and cut off. The grooves for cigarettes may be put in the rim of the ash trays with a gouge or a round file.

Other ideas will suggest themselves to you as you progress with this work.

A New Stunt for Model Makers . . . Building a Miniature

Earth-to-Mars Rocket Plane

By Donald W. Clark

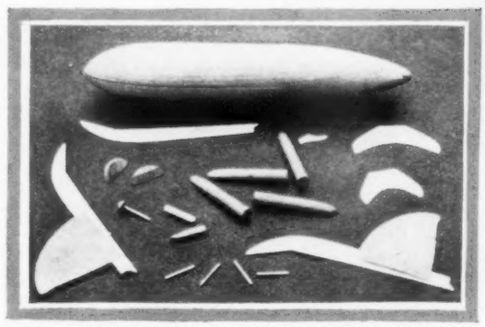
INTERPLANETARY rocket planes, although actually far in the future, are now familiar to everyone because of constant reference to them in radio and comic-strip adventure stories. No one knows what these strange aircraft will look like, but there is no reason why the model maker should not delve into the future a bit on his own account.

The rocket-plane design illustrated is, of course, purely imaginary. It would be controlled by the tail fins, by the wings, which could be tilted together or separately, and by two small movable rocket tubes at the front end.

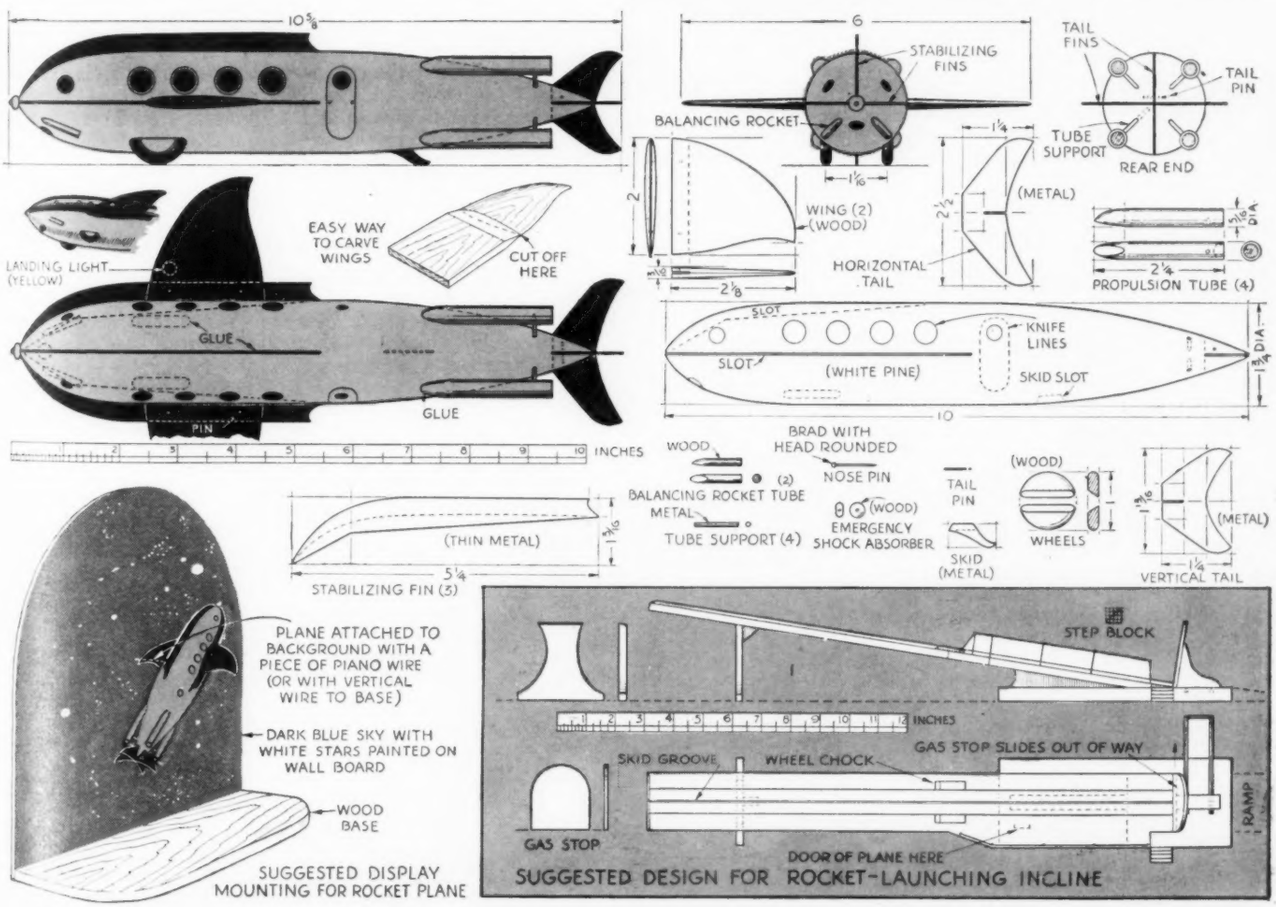
This model is made up of twenty-two simple parts, glued and pinned together. The body can be carved to shape with a knife, if no lathe is available, and smoothed with sandpaper. Saw two slots in the rear end to take the tail fins, and three long slots at the front end, as shown, to take the stabilizing fins, which should be glued on. Pin the wings to these and glue them to the body. Fasten the propulsion tubes with 1/16 in. diameter wire pins and glue. Outline the door with the point of a knife. Make cardboard templates for cutting metal parts.

Give the complete ship a coat of flat white paint. Next paint the body, propulsion tubes, wheels, shock absorber, and balancing rockets red; and the wings, stabilizing fins, tail fins, windows, tires, skid, and rear ends of tubes, black.

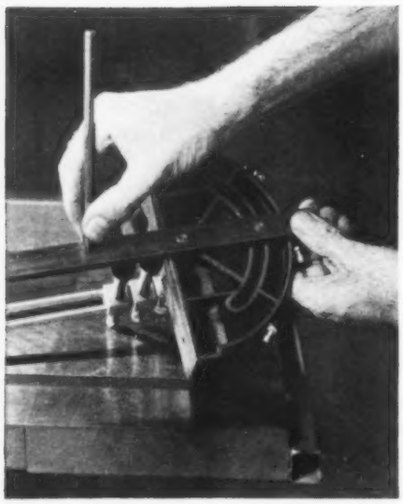
The model will look well if mounted on the suggested launching incline. Better still, a decorative background can be made from wall board painted blue or half a sheet of dark blue show-card board. Paint some light blue dots on it and one yellow circle to represent the moon, and, if desired, another circle in an upper corner to stand for Mars. In front of this background, place the ship as shown.

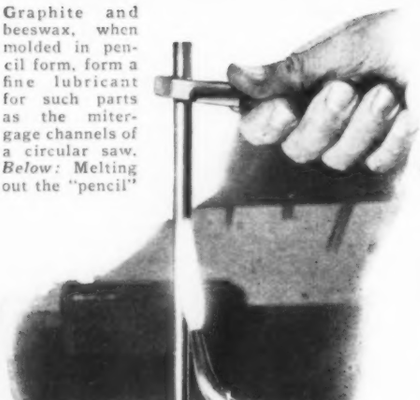


Finished rocket plane model and a photograph of the parts before assembly. If desired, the model can be lettered "Starocket—Earth-Mars Line"



Side, top, and front views; the rear end; details of the body, wings, tail units, tubes, and other parts; and two methods of mounting the model





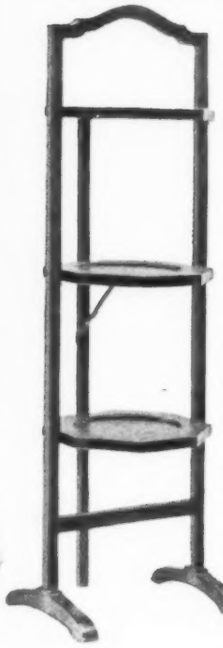
Graphite and beeswax, when molded in pencil form, form a fine lubricant for such parts as the miter-gage channels of a circular saw. *Below:* Melting out the "pencil"

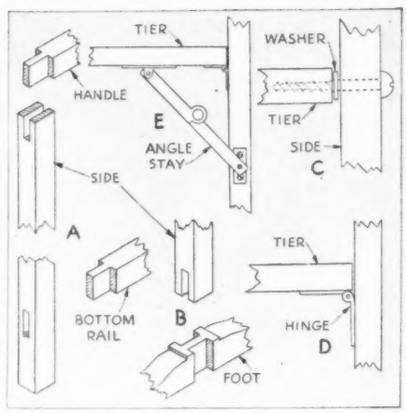
GREASELESS LUBRICANT USED LIKE PENCIL

You will find many uses around the home, shop, and garage for a lubricating pencil made of finely powdered graphite and beeswax. A thin coating of the graphite-carrying wax rubbed on the latches of automobile doors will make them work smoothly, yet will not come off on clothing. For lubricating the miter-gage channels in circular saw tables, for waxing nails so that they can be driven more easily, and for hundreds of other jobs, the pencil will be found valuable.

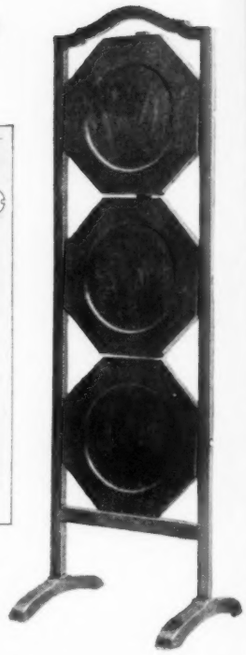
Obtain some beeswax and about an equal volume of very fine (impalpable) graphite. Melt the wax in an old can and stir in the graphite. Pour the wax into a metal tube of from $\frac{3}{8}$ to $\frac{1}{2}$ in. inside diameter, the lower end of which should be plugged. After the mixture has solidified, heat the tube gently with a torch or gas flame until the wax pencil slides out, but first remove the plug in the lower end of the tube to prevent suction. A layer or two of paper glued around the pencil makes it easier to hold. The graphite is the lubricating medium. The purpose of the wax is nothing more than to serve as a carrier.—JOHN C. WORKLEY.

LIGHT FOLDING CAKE STAND EASILY CARRIED AROUND





Details of the various joints used in constructing the three-tier cake stand. The tiers are pivoted to the sidepieces as at *C* and hinged to a rear leg as at *E*



The cake stand opened for use. **Note the rule-**joint stay from the middle tier to the rear leg

HERE is an extremely useful and attractive piece of furniture that any amateur craftsman can make. The choice of wood will be largely influenced by the other furniture in the room and is, therefore, entirely a personal matter. The parts required (finished sizes) are two uprights $\frac{3}{4}$ by $\frac{3}{4}$ by 34 in., one top rail or handle $\frac{3}{4}$ by $2\frac{1}{2}$ by 11 in., one bottom rail $\frac{3}{4}$ by $\frac{3}{4}$ by 11 in., two feet $\frac{3}{4}$ by $2\frac{1}{2}$ by 9 in., one back stay $\frac{1}{2}$ by $\frac{3}{4}$ by 28 in., and three tiers $\frac{5}{8}$ by $9\frac{1}{2}$ by $9\frac{1}{2}$ in.

How the handle and bottom rail are joined to the sidepieces is shown in the drawings at *A*. The first job will be to construct this part of the stand. Next make the joints for the two sides and feet as shown at *B*. When this has been completed, the handle and two feet should be shaped, and this part of the job cleaned up and glued together.

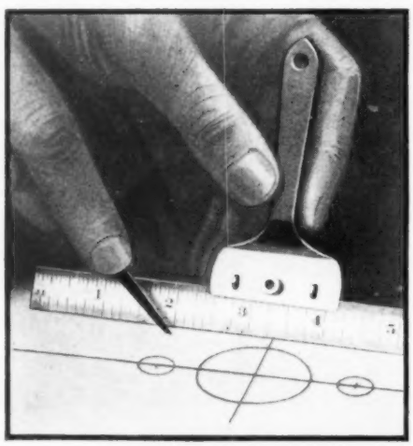
The three tiers should now be made and pivoted by means of a roundheaded screw, as shown at *C*. This is free to turn easily in the sidepiece, but is screwed tightly into the edge of the tier. A washer should be inserted between the two.

To prevent the plates or dishes from sliding off, the center of the tiers should be recessed. This can be done on a lathe in a very few minutes or, if a lathe is not available, the recess may be cut out with a router. If preferred, instead of recessing the middle, a strip of molding can be fixed around the edges.

In order to operate all the three tiers together, they are hinged to a wooden stay; this also forms an extra leg when the cake stand is in use, thus giving added rigidity. The position of the hinge is shown at *D*. A brass angle lid stay should be screwed to the underneath side of the center tier and on the side of the wooden stay at at *E*. This keeps the three tiers rigid and prevents them tipping up when in use.

Finally clean up and finish the cake stand by whatever method you prefer. An excellent way is to use a water stain, paste wood filler if required, and several thin coats of shellac. One of the new wax-process finishes is even simpler—two coats of a special flat finish and one of paste wax.—RAYMOND S. FORBES.

CONVENIENT HANDLE FOR STEEL SCALE



A TEN-CENT holder for old razor blades forms a convenient handle for the light steel scales used by mechanics for laying out and measuring small work. It can be fastened securely to the rule without marring or bending it, and with it the scale is easily laid against the work for measuring and scribing. It also makes the scale easy to pick up when laid on the bench or other surfaces.—F. W. B.

MODEL ANCHOR CHAINS

ANCHOR chains for ship models can be made from copper wire of an appropriate size. Bend a number of rings around a match stick or other form, fit them together, and hold the chain over a burning match to color.—DALE W. BRAHAM.

BLUEPRINTS for Popular Science Monthly projects are listed on page 88.

THE HOMEWORKSHOP GUILD MOVES FAST

Latest News from National Headquarters

•

Many More Clubs Formed

•

Hardware Dealers Help

•

Recent Club Activities

Toys made by Rockford Homecraft Club and, left to right, LeVern T. Ryder, president, Robert Horner, treasurer, and Frank Burrett, George Lustig, and Vern Prentice, members of the club's toy committee

AS THE new home workshop club movement gains momentum, club after club is reporting its organization to the headquarters of the National Homeworkshop Guild in Rockford, Ill., and applying for a local charter. A list of the new clubs and their officers appears at the end of this article. They are distributed across the continent from New York to the State of Washington and from Florida to the Great Lakes.

The growth of the Guild and the enthusiasm with which it has been hailed by amateur craftsmen everywhere are not surprising, because it offers something that never before existed in the home workshop field—an opportunity for all those interested in making things to enjoy real coöperation and companionship in their hobbies. The purpose of the Guild is solely to promote the advancement of all varieties of what may be called "homecraft." It has nothing to sell; in fact, it is strictly noncommercial. Its national officers and directors are serving without pay, and it is sponsored by an advisory council of men of national prominence in various fields.

The Guild's incalculable value to homecrafters lies in just this: It provides the experience, the information, and the substantial support necessary to insure the success of any local home workshop club formed under its auspices and conducted according to its suggestions. Just how it does this, is explained fully in literature which anyone may obtain without obligation by filling out the coupon at the end of this article. To regularly organized clubs, the Guild also sends monthly bulletins, and the secretary of each club receives a subscription to POPULAR SCIENCE MONTHLY, the official magazine of the Guild. Other services also are provided.

Those clubs already formed have received their second and third monthly bulletins. The third bulletin and certain others to follow are supplemented by special woodworking plan sheets with drawings and instructions. These are intended for the club library, but the sheets have been printed on tracing paper so that they can be blueprinted by the club for the individual use of any members who wish to make the projects described.

A survey is being made to find speakers and demonstrators for local clubs. Every manufacturer and large distributor in the home workshop field has been asked to coöperate, in addition to those who have already voluntarily offered to help, and the resulting information will be tabulated by the speakers' bureau of the Guild and made available in the form of bulletins for the use of all local clubs.

Another campaign the Guild is conducting is among hardware dealers. It has taken steps to place full information about its purposes and activities in the hands of practically all the hardware dealers in the country. Since every home worker visits a hardware store at frequent intervals and since hardware men have the widest possible acquaintance among *(Continued on page 100)*

ADVISORY COUNCIL

•

Professor Collins P. Bliss
Dean of the College of Engineering, New York University

Professor Clyde A. Bowman
Dean of the School of Industrial Education, Stout Institute, Menomonie, Wisc.

Harvey Wiley Corbett
Architect, New York City

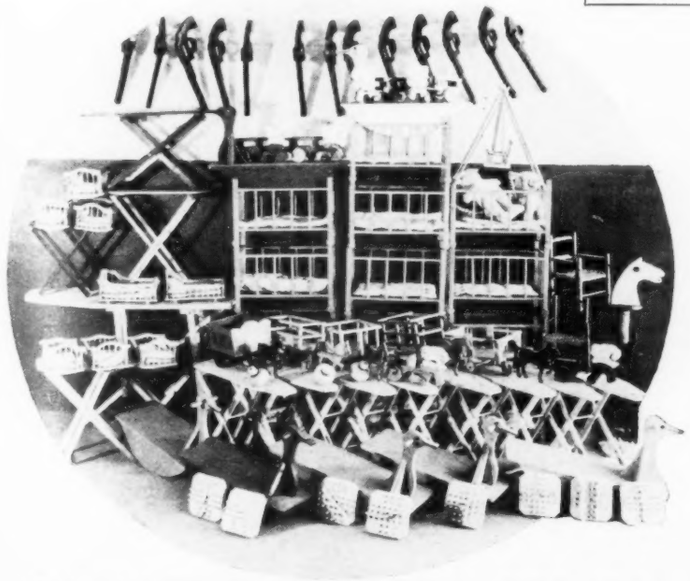
Dr. Hugh S. Cumming
Surgeon-General, United States Public Health Service

Maj.-Gen. Benj. D. Foulois
Chief of the Air Corps, U. S. Army

Capt. E. Armitage McCann
Founder, Ship Model Maker's Club

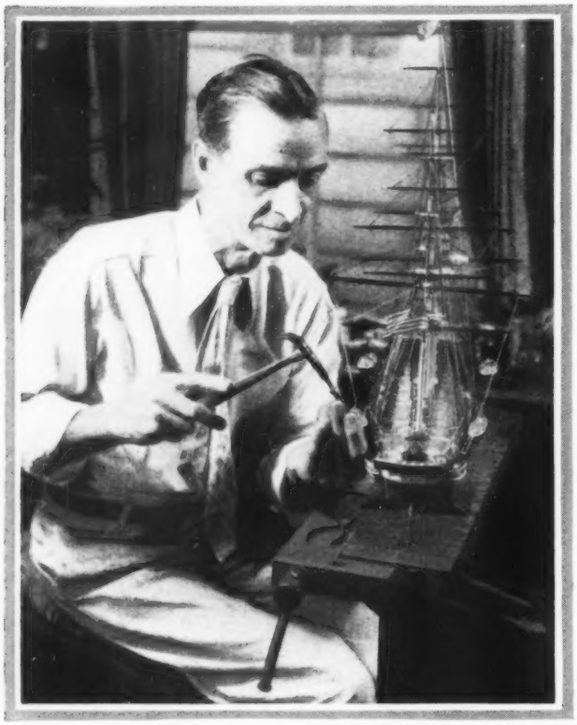
Dr. Francis G. Pease
Astronomer, Mt. Wilson Observatory

Frank A. Vanderlip
Banker and Publicist, New York



The Amarillo Homeworkshop Club, of Amarillo, Texas, made these toys in record time. Wives of the members helped and also dressed twenty-five dolls

Making Masts *and* Spars



The *Hartford* nears completion under Captain McCann's skillful fingers. Note how perfectly masts and yards align

OUR model of the sloop-of-war *Hartford*, Admiral Farragut's famous ship, has now advanced far enough for us to make the spars and begin the rigging. New readers who wish to build this model, which is the finest of all those I have designed for POPULAR SCIENCE MONTHLY, should refer to the three installments previously published (P.S.M., Jan. '34, p. 57, Feb. p. 66, and Mar. p. 71.)

The rigging of the *Hartford* has more historic importance than that of any other ship in the United States navy because it was from the rigging that Farragut directed the Battle of Mobile Bay and shouted his defiant order: "Damn the torpedoes! Full steam ahead."

The *Hartford* was steaming in line to the attack of Fort Morgan on August 5, 1864. Every man was at his station, including Captain Percival Drayton and his staff. Near them was chief quartermaster John H. Knowles. The admiral was in the port main shrouds, twenty-five feet above the deck. Silence was maintained aboard until the *Hartford* was in easy range of the fort. Then the thunderous broadsides of the ship took part in the awful cannonade.

During the action Captain Drayton, fearing that some damage to the rigging might pitch Farragut overboard, sent Knowles to secure him. "I went up," said Knowles, "with a piece of lead line and made it fast to one of the forward shrouds and then took it around the admiral to the after shroud. The admiral said, 'Never mind, I'm all right,' but I went ahead and obeyed orders." Later Farragut, undoing the lashing climbed higher still. While he was here, one of the monitors struck a torpedo and sank. The *Brooklyn*, which was leading, turned back to go around what seemed to be a nest of torpedoes. The whole line was in danger of being huddled together under the fire of the forts. Farragut then gave his immortal command and boldly took the lead, the fleet following. The torpedo cases could be heard rapping against the ship's bottom, but none exploded.

The rigging for the *Hartford* is much as for any other full-rigged battleship of her time, though here as elsewhere she is somewhat of a mixture of old and new ideas. She had wire standing rigging, and one photograph of her shows what looks very much like turnbuckles in place of deadeyes, but other pictures and all plans, old or newer, call for deadeyes and lanyards, so we will rig her with those. For the rigging use cord, but keep the sizes smaller than would be required to indicate hemp rope.

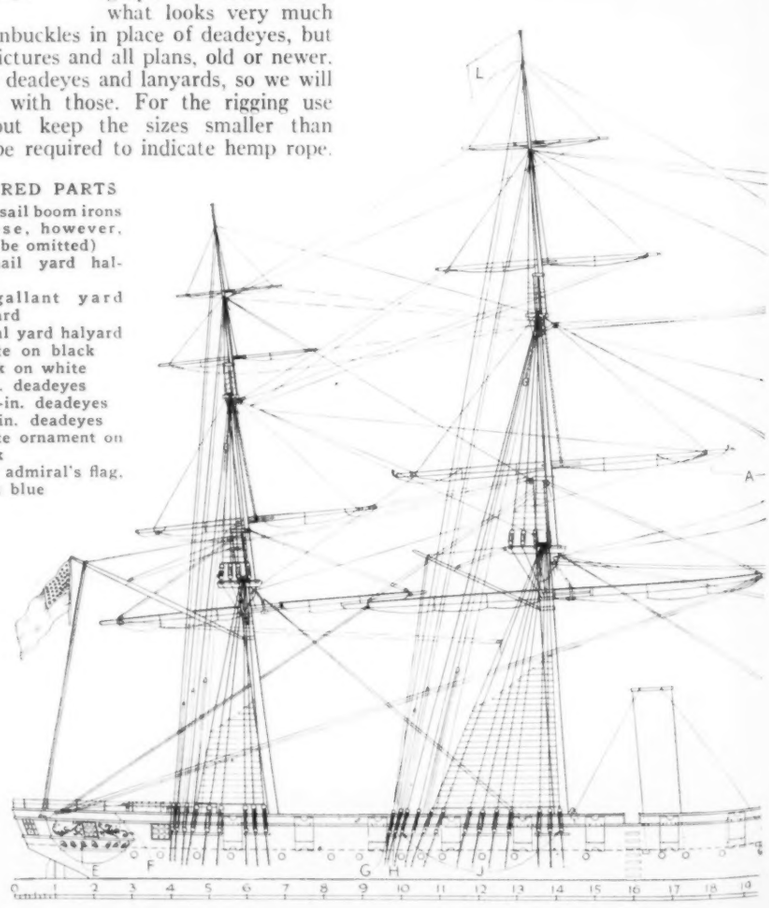
First we must make a complete set of spars. Their dimensions can be found from the rigging plan and the table on page 102.

The lowermasts are round and slightly tapered from the deck to the trestletrees, from which point they are square. They are slightly flattened to take the cheeks, the top edges of which are horizontal when the mast is in position—that is, not at a right angle to the masts. At the top ends the masts are squared a bit smaller for the caps. The first band has a lug on it to take the pin of the truss; the second band has either one or three bolts soldered on each side to take the futtock shrouds; and the third band has an eye abaft for the gooseneck for the spencer (trysail) gaff. These I formed from thin brass on a stick the same size as the mast. I turned up a lug on each end and soldered them together, then put them on their masts at the right height.

At ½-in. intervals from the deck, up to the spencer band, I put mast bands, to hold the supposed several parts of the mast together. These I made of writing paper, glued and wound around several times. The lower one is painted black for a pin band. For holding the belaying pins I made eyebolts from ½-in. pins, and drove them into the mast through the band after I had soldered other pins of

LETTERED PARTS

A—Stunsail boom irons (these, however, may be omitted)
B—Topsail yard halyard
C—Topgallant yard halyard
D—Royal yard halyard
E—White on black
F—Black on white
G—⅛-in. deadeyes
H—5/32-in. deadeyes
J—3/16-in. deadeyes
K—White ornament on black
L—Rear admiral's flag, plain blue

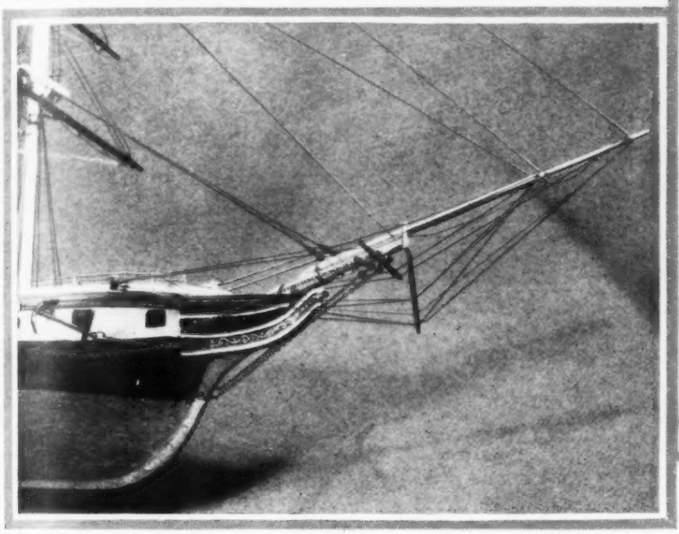


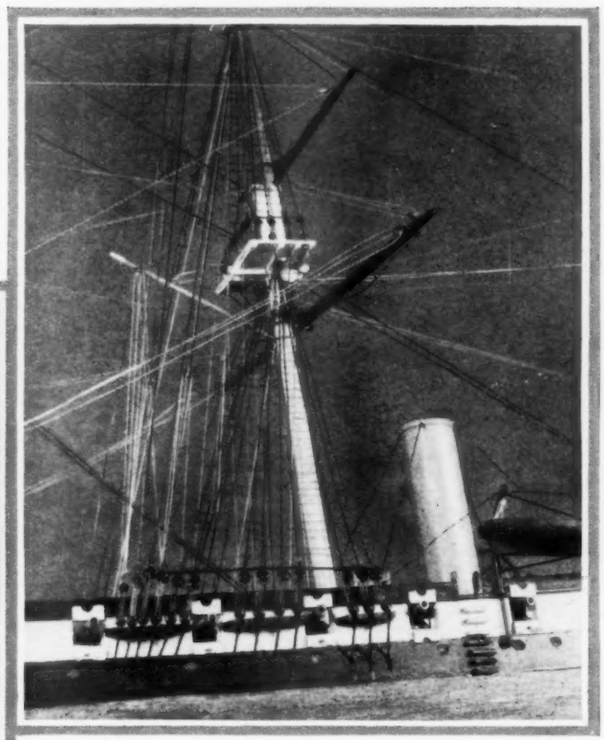
for the *HARTFORD Model*

By Captain E. Armitage McCann

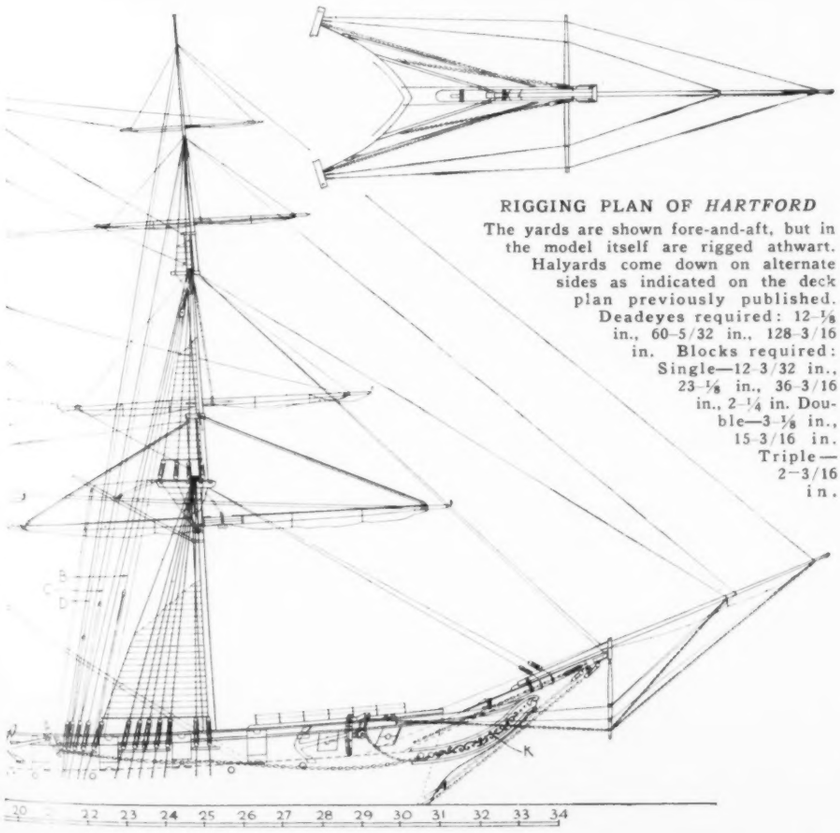
sufficient length in the eyes to represent the belaying pins. To prevent the sails from chafing on the mast bands, long battens are fitted over them on the foreside. These are called paunches. I made them from strips of Bristol board, notched to take the bands and glued on. With the exception of the four bands especially mentioned, the masts are all white.

The bowsprit tapers slightly from where it comes out of the bow and is round with a flat top. The end is squared for the





A view of the main lowermast to show deadeyes, shrouds, and underside of top. *At left:* Bowsprit, jib boom, and rigging



RIGGING PLAN OF *HARTFORD*

The yards are shown fore-and-aft, but in the model itself are rigged athwart. Halyards come down on alternate sides as indicated on the deck plan previously published. Deadeyes required: 12-⅛ in., 60-5/32 in., 128-3/16 in. Blocks required: Single—12-3/32 in., 23-⅛ in., 36-3/16 in., 2-¼ in. Double—3-⅜ in., 15-3/16 in. Triple—2—3/16 in.

cap. Just abaft this are cleats on each side called bees, with holes through them for the topmast stays. Underneath are two 3/16-in. deadeyes for the bobstays. I stropped these—put straps on them—with wire, brought through the sprit and twisted together on top. On each side will be other deadeyes for the bowsprit shrouds, similarly fastened. On top there is a cleat for the jib boom end to rest on and another to hold the gammoning up, and two little cleats underneath for the forestay.

The topmasts are slightly tapered and are squared from the trestletrees up, with smaller squares for the caps. They have holes athwart near the heel for the fids, another at an angle for the mast ropes, and fore-and-aft holes 3/16 in. from the trestletrees for the ties of the halyards.

The topgallant masts and royal masts are in one spar, with practically no taper, but they have a dip or shoulder at the head of the topgallant mast and royal mast, and a sharp taper to the pole. They are bored for fid holes and halyards. The masts are white where they double and at the pole, but a natural pitch-pine color where the yards slide up and down.

The jib boom tapers slightly from the cap to the heel and then slightly from there to the end, but most of the thickness is taken off at the topmast, topgallant and royal stays, where there are shoulders. Within the cap and also the extreme end are white, the rest natural.

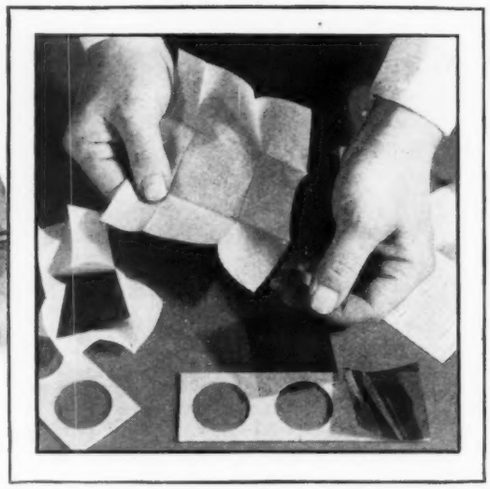
The martingale *(Continued on page 102)*

BLUEPRINTS for Popular Science Monthly projects are listed on page 88.

How to Improve Your PHOTOGRAPHS

by using a set of

Color Filters



Inexpensive gelatine filters can be mounted between pieces of cardboard and slipped into a carrier attached to the lens

By *Frederick D. Ryder, Jr.*

THE introduction of panchromatic roll film and film packs opens up absorbingly interesting photographic fields to the amateur camera enthusiast. All sorts of effects formerly possible only with professional equipment are now at the command of anyone owning the simplest type of hand camera.

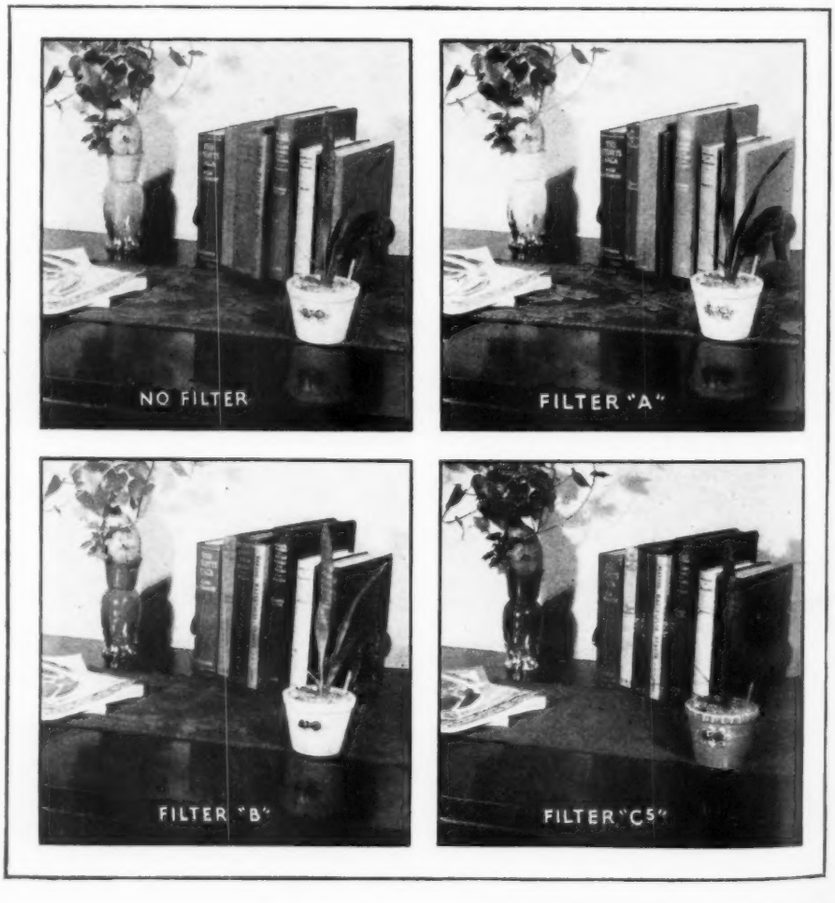
You can, for example, produce the most beautiful cloud pictures at snapshot speed, get weird moonlight effects in bright sunlight, do amazing tricks in taking pictures of flowers or gardens, and, in general, make the various colors behave in your photographs like a troup of trained actors. All these stunts and scores of others are accomplished by the proper use of simple and inexpensive color filters.

In order to use photographic filters so as to get just the results you want, you must have clearly in mind what a filter is and what it does. All light, as you know, is colored. There really is no such thing as white light. What our eyes see as white light actually is a combination of colored light. When you hold up a piece of colored glass, red for instance, the glass doesn't turn the light into red; it merely cuts off or absorbs a certain percentage of the blue-violet and green rays in the white light.

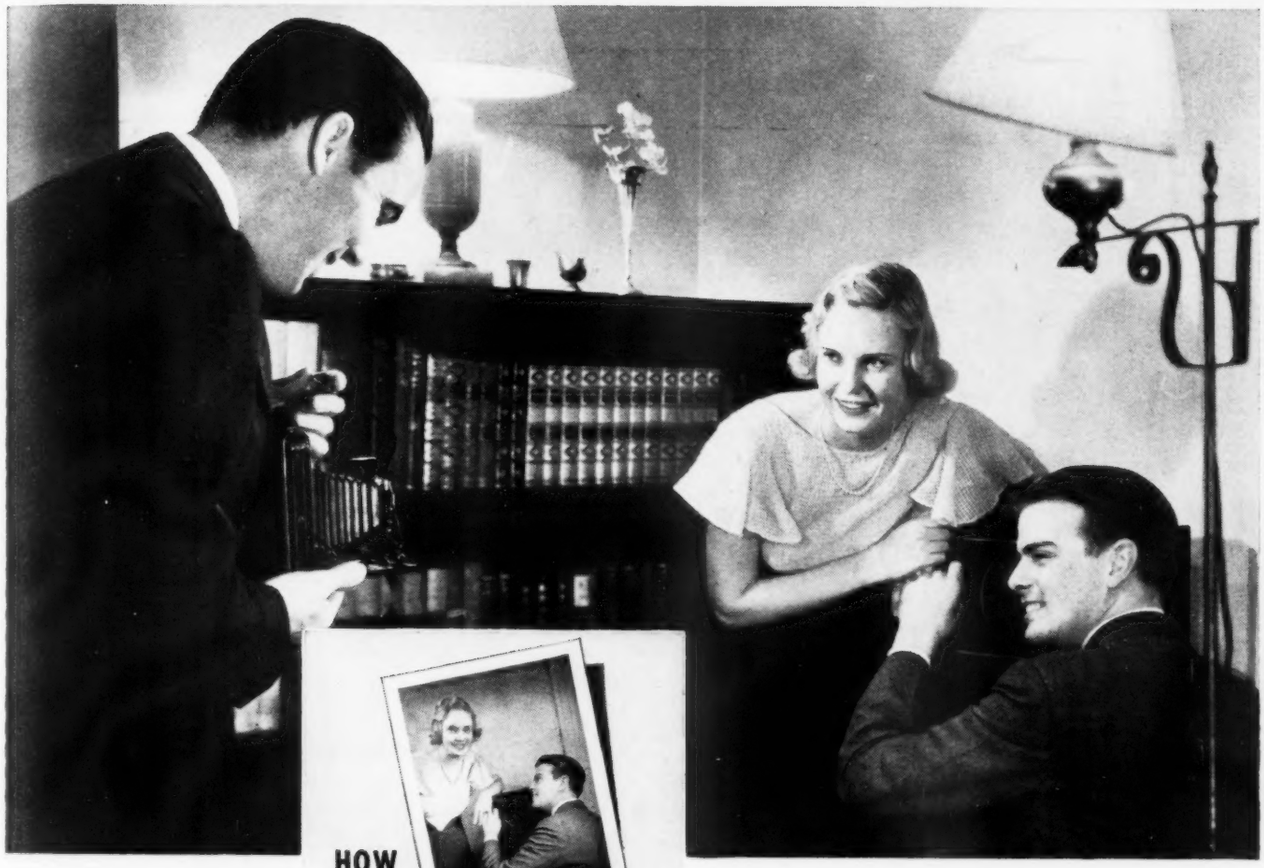
Similarly, a photographic filter is a substance which, when placed in the path of the light streaming through the lens of your camera, will absorb some of it and thereby prevent it from acting on the film.

The colored objects you photograph also are light filters except that they operate by reflection instead of direct transmission. An object that appears red, for example, is one that is absorbing blue-violet and green rays. A bright yellow object is one that is soaking up blue light and reflecting the rest of the components of what we call white light. In other words, white light minus the blue rays appears to be yellow light to our eyes. And a yellow object will reflect red or orange rays as strongly as a white object.

In a previous article (P. S. M., Aug. '33, p. 74) I explained how panchromatic film, even when used without any filter, gives good rendering of color values in monochrome—that is, in shades of gray. True color rendering is not, however, always desirable. In many cases far better pictures result if the strength of the color is toned down or stepped up with the aid of filters. Take the case, for example, of a light yellow house being photographed against a blue sky. It may *(Continued on page 78)*



Snapshots at Night !



HOW TO GET THIS PICTURE

● **LIGHTS: Two Mazda Photofloods in lamp "A"; one Photoflood in lamp "B." EXPOSURE: 1/25 second at f.6.3. FILM: Kodak "SS."**

KODAK "SS"—the lightning-fast film, with green lettering flashes on the familiar yellow box.

PHOTOFLOODS (35 cents each) give intensely bright light for about 2 hours, good for lots of pictures.

KODAFLECTOR — Inexpensive, efficient . . . makes 2 Photoflood bulbs do the work of 9. Complete, with stand, reflectors and cord, $5.

INTERESTING FREE FOLDER

For more information on indoor pictures ask your dealer for the new folder, "Snapshots at Night." Or write to us direct. Eastman Kodak Company, Rochester, New York.

. . . with Eastman's remarkable new "SS" film

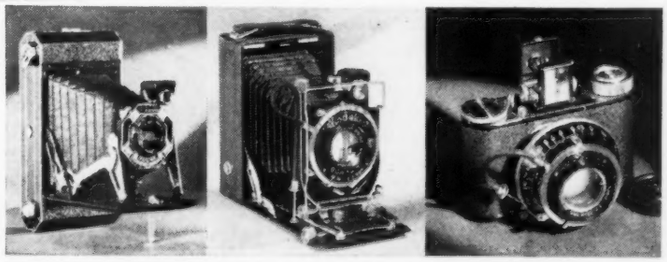
IT WAS WELCOME NEWS. It spread in a hurry. Now . . . for the first time . . . thousands are making snapshots indoors—at NIGHT!

Use any camera with an *f*.6.3 (or faster) lens, two or three Mazda Photoflood bulbs (they screw into any light socket), and the new Kodak Super Sensitive Panchromatic Film. "SS" Film, Eastman's latest, has three times the speed of ordinary film under artificial light.

Just use the camera as you would for an outdoor snapshot—hold it in your hand and press the button. Click—you've made a snapshot at NIGHT!

FINE CAMERAS . . . Ideal for Night Snapshots

KODAK SIX-20 (Below at left), *f*.6.3 lens, 2¼ x 3¼ pictures, $17.50. **KODAK SIX-16,** 2½ x 4¼ pictures, $20. **RECOMAR 18** (center) . . . a versatile camera. Ground glass back, self-timer, double-extension bellows, 1/250 Compur shutter, *f*.4.5 lens—$46. **PUPILLE** (right) . . . miniature camera. Ultra-fast *f*.2 lens, speeds up to 1/300. 16 pictures each loading. With case, range finder, two filters—$90.



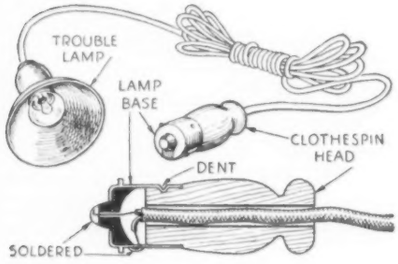
Ingenious Ideas

FOR CAR OWNERS

Our Readers Furnish New Suggestions For Handy Repairs and Improvements

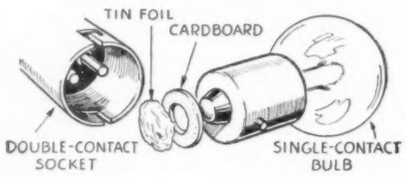
An emergency window can be made of cardboard and sheet celluloid and installed to replace broken glass, as shown above

WHEN a car window is shattered, it is sometimes a week or more before a new glass can be obtained and installed. A temporary repair, however, can be made with heavy cardboard and a large piece of sheet celluloid of the type sold in auto supply stores for repairing side curtains. Trim the cardboard to the full width of the window opening, leaving about three inches to spare in the length. Then cut the opening for the window and stitch the celluloid in place with heavy thread. The makeshift window finally can be installed by inserting the bottom edge in the regular opening in the door, (see illustration), lifting it until the top edge fits snugly in the felt groove at the top of the frame, and jamming two wood or rubber wedges between the cardboard and the frame along the bottom edge on the inside to hold it in place.—J. Z.



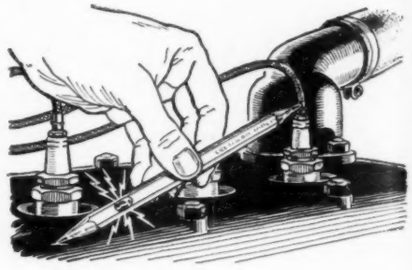
Trouble-Lamp Plug From Old Bulb Base

OWNERS of cars fitted with exposed dashboard lights can make a convenient trouble-lamp plug from the base of a broken bulb and the end of an ordinary clothespin. When completed the plug makes it a simple matter to connect an auxiliary extension to the car's battery. The handle for the plug is made by cutting the upper half from a wooden clothespin. Drill a three-sixteenths-inch hole through the center and file the lower end to be a tight fit in the bulb base. Thread the extension cord through the handle, solder the wires to the filament leads in the base, and finally drive the handle into the base. Then, using a pointed nail, make three or four deep dents in the metal sides of the bulb base. These will serve to hold the handle in place. The same kink can be used to advantage on newer cars if the owners will install a bayonet-type socket under the dashboard and connect it to the battery supply. For durability, it will be best to use a rubber-covered cord.—C. B.



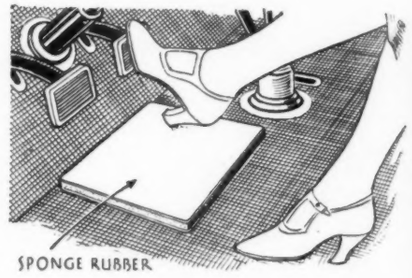
Repairing Headlights

IF YOUR car uses double-filament bulbs in the headlights and they happen to burn out when you are traveling along some out-of-the-way road, you may find that the nearest service station carries only the single-filament variety. Placed in the regular double-filament sockets, these single-contact bulbs will not light, but by making use of some scraps of cardboard and a piece of foil from your cigarette package you can make them serve. First cut a cardboard washer, making it large enough to cover the base of the bulb and the hole big enough to allow the single contact to project through. Then fold the foil to obtain several thicknesses. Finally, with the washer and tin foil held in place with a bit of chewing gum, place the bulb in the socket. Arranged in this way, the bulb will light as contact will be made no matter which way the light switch is thrown.—P. L. H.



Spark-Plug Tester

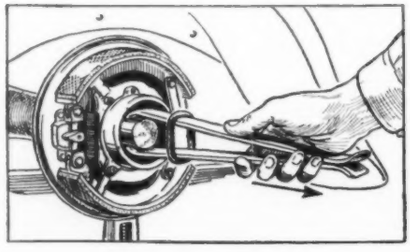
MADE from a pencil, the spark-plug tester, above, forms a valuable addition to any automobile repair kit. Sharpen both ends of a large pencil and then drill a small hole through it at about its middle. In use, the projecting lead at one end is held against the terminal on top of the spark plug while the other end is grounded against the motor head. If the spark plug is functioning, a spark will jump across the gap.—J. M. V.



Sponge-Rubber Mat

PLACED on the floor directly beneath the brake and clutch pedals, a rectangle of sponge rubber will cover any holes worn by the driver's heels and will protect the high heels of lady drivers. Cut the sponge rubber to the desired size and cement it to the flooring mat with rubber-patching cement or ordinary water glass (sodium silicate).—E. W. B.

Tool to Grip End of Broken Axle



BY USING two tire irons and a large link from a chain you can improvise a good tool for gripping the end of a broken rear axle, as is shown in the illustration at the left. Simply slip the tire irons over the axle end and then slide the link over the ends of the tire irons, pushing it toward the axle until it holds them firmly together. The projecting ends of the irons can be used as a handle as shown at the left.—A. B.

A BLOW-OUT IN THE MAKING MAY BE IN YOUR TIRE RIGHT NOW

BLOW-OUT! WHY THESE TIRES WON'T BLOW OUT. THE DEALER TOLD ME SO
SLOWER, DEAR! I'M SO AFRAID OF A BLOW-OUT
—but they did have a blow-out!
GET A SET OF GOODRICH SILVERTOWNS — THEY HAVE THE GOLDEN PLY THAT PROTECTS YOU FROM BLOW-OUTS
LUCKY WE WEREN'T ALL KILLED

HOW GOLDEN PLY TIRE SAVES MOTORISTS' LIVES

NEW SILVERTOWN PREVENTS GREAT CAUSE OF BLOW-OUTS—GIVES MONTHS OF EXTRA MILEAGE—FREE!

A BLOW-OUT is like a snake in the grass. Unseen in advance, it strikes when you least expect it. Often when you think your tires are still good for thousands of miles. Often when you and your loved ones are *speeding* along some fast, crowded highway.

BANG! A blow-out. Desperately your hands grip the steering wheel. With all your strength you clamp down the foot-brake. No use. Your car swerves. You can't steer. Trees, ditches or speeding traffic block the way. Your lives are in the hands of Fate.

To protect motorists from blow-outs every new Goodrich Silvertown has the amazing Life-Saver Golden Ply. This remarkable invention resists heat. Rubber and fabric don't separate. Thus blisters don't form inside the tire. The great, unseen cause of blow-outs is prevented *before* it begins. The Golden Ply makes you *3 times safer than before.* And here's proof.

Racing daredevils tested it out at breakneck speeds. On the world's fastest track. Gave it everything they had. Rubber got so hot it fairly smoked. *Not one blow-out.* Similar tires *without* the Life-Saver Golden Ply failed at one-third the distance the Golden Ply Silvertowns were run. And what's more, the Golden Ply Silvertowns kept right on eating up the miles.

In addition to being 3 times safer from blow-outs with the new Goodrich Silvertowns on your car, you'll get plenty of extra mileage, too. For, with the destructive effects of internal heat overcome by the Golden Ply, the big, rugged Silvertown outwears ordinary tires by *months.*

No extra cost!

Enjoy the priceless feeling of security every time you sit behind the wheel. Get more mileage than you ever got out of tires before. Play safe! See your nearest Goodrich dealer today about a set of Golden Ply Silvertowns for your car. *And remember, they cost not a penny more than other standard tires.*

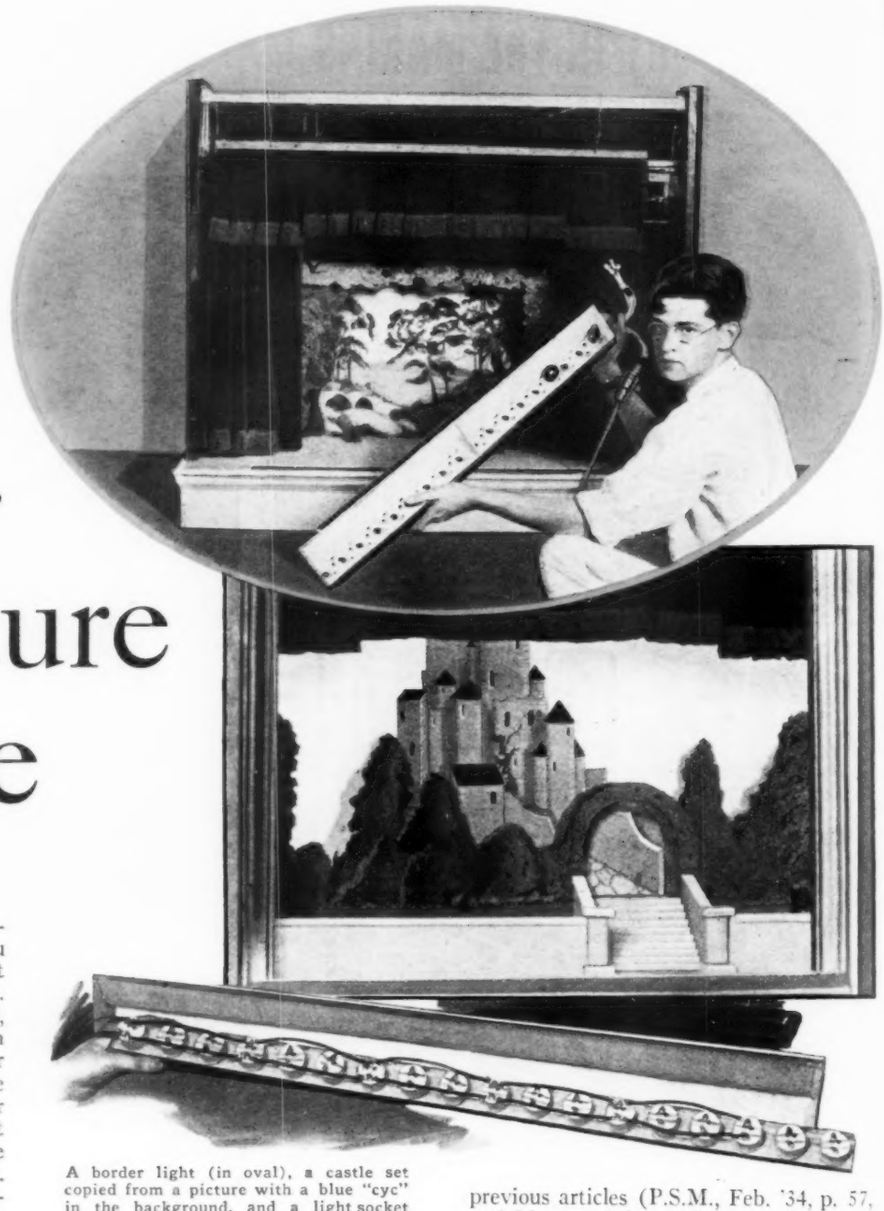
FREE! Handsome emblem with red crystal reflector to protect you if your tail light goes out. Go to your Goodrich dealer, join Silvertown Safety League, and receive one FREE. Or send 10¢ (to cover packing and mailing) to Dept. 329, The B. F. Goodrich Rubber Co., Akron, O.

Goodrich *Safety* **Silvertown**
WITH LIFE-SAVER GOLDEN PLY

Copyright, 1934, The B. F. Goodrich Rubber Co.

Benjamin W. Hicks *tells*

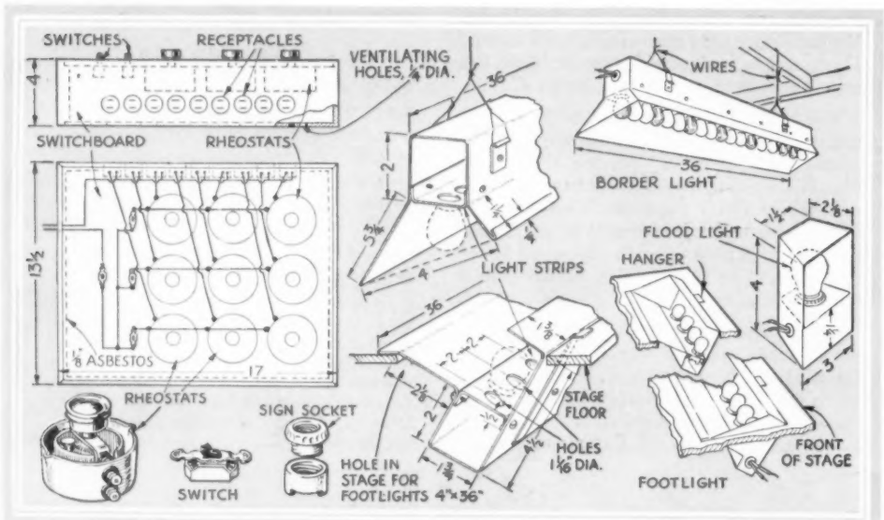
How to Light Your Miniature Stage



A border light (in oval), a castle set copied from a picture with a blue "cyc" in the background, and a light socket strip before being fastened in its trough. One of the three color circuits is wired

TO achieve the most realistic effect with any miniature stage, you should install lighting equipment similar to that used on a regular stage. Complete control of the light is essential, and each circuit should be provided with separate dimmers or rheostats. The border and footlights should be wired for three colors—red, blue, and either amber or clear. Of course, if your stage is an exact model of any particular stage, choose the same colors that are used on that stage.

The accompanying illustrations and following instructions are intended to apply to the miniature stage described in two previous articles (P.S.M., Feb. '34, p. 57, and Mar., p. 73), which was built on the scale of 1 in. equals 1 ft., but the same principles can be used for a model of any size or design.



Plan view and upper edge of the switchboard, and sketches showing how the footlights, border lights, and flood lights are made. Compare these with the photographs at the bottom of page 86

Good stage lighting does four things, namely: Illuminate the stage; show the time of day and the season of the year; give the stage depth with light and shade; and provide the proper psychological effect with color lighting. Blue represents cold or night; red, fire and hate; green, spring and hope; black or a dark stage, death, night, or crime.

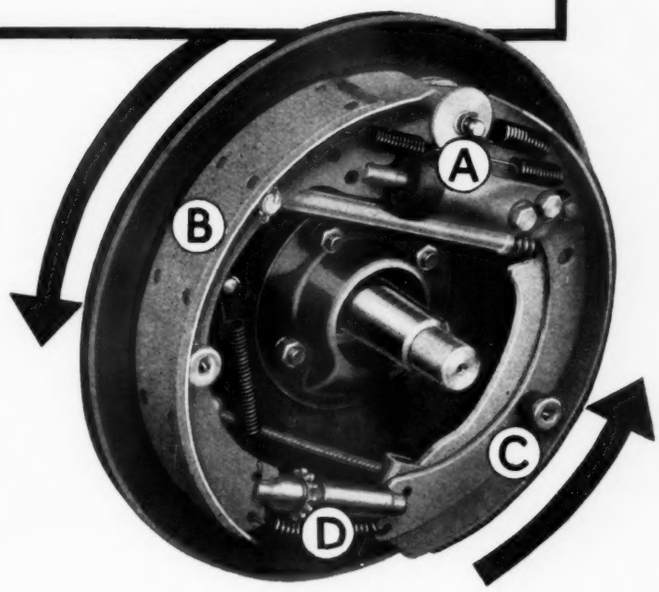
The equipment necessary includes two border lights, footlights, and a switchboard. Flood lights and other small lighting fixtures can be added from time to time as needed.

Most of the materials (see list on page 87) can be purchased from a local supply house or electrical dealer. The tin work can be done at the neighborhood tinner's for a reasonable sum if one is not equipped to do it at home.

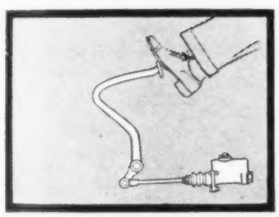
Footlights give a continuous strip of light across the front of the stage and should *(Continued on page 86)*

What is the difference between HYDRAULIC BRAKES *and* SUPER-HYDRAULIC BRAKES?

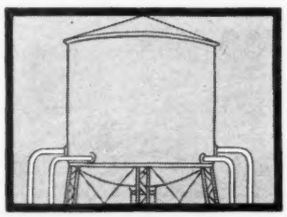
Outstanding advantage of Oldsmobile's super-hydraulic brakes is the controlled Servo, or self-energizing, action of the brake shoes. The hydraulically-operated piston within the wheel cylinder (A) forces primary shoe (B) against the revolving brake drum. As the drum revolves it attempts to carry the expanding primary shoe with it. This effort, transmitted through adjusting screw (D) forces the secondary shoe (C) into contact with the drum—both shoes wrapping tighter and tighter against the drum until the wheel stops. Momentum of car multiplies the braking power—the greater the speed, the greater the pressure against the brake drums. No previous hydraulic brake is self-energizing.



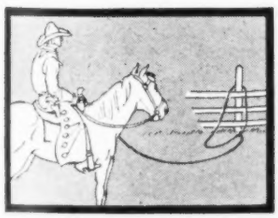
Oldsmobile All-Feature models for 1934 are equipped with Super-Hydraulic brakes. The first *self-energizing* hydraulic brakes, they grip smoothly with slightest foot pressure. Quick, easy, non-skid stopping under any road condition.



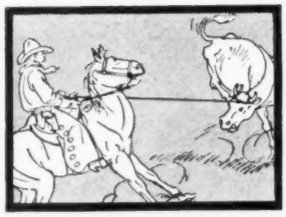
Master hydraulic cylinder is mounted close to the foot pedal, permitting direct linkage with minimum friction, so that very slight pedal pressure is needed. Master cylinder forces fluid under pressure to each drum through pressure-tested steel tubing.



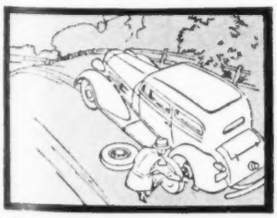
Water from any fluid tank flows with equal pressure from all outlets. In the same way, hydraulic pressure is always equal on all four brakes in the 1934 Oldsmobile.



Throw a lasso over a post and your own arms must supply the energy to draw it tight. In the same way, your foot must supply the energy to make ordinary brakes take a firm hold. At high speeds, effective braking becomes very difficult. And even at low speeds it is tiring.



When a lasso is thrown over a steer, the animal supplies the energy to draw the lasso tight. The faster the animal travels, the tighter the lasso is applied. In the same way, self-energizing brakes supply the energy to stop the car. The faster the car is traveling the greater the braking.



Mechanical emergency brakes on rear wheels act on rear service brakes, independent of super hydraulic system. Superior to entire braking system of former two-wheel brake cars. With an Oldsmobile you can park on a steep hill while tire is being changed.

10 other points of OLDSMOBILE ENGINEERING EXCELLENCE

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OLDSMOBILE

Six $640 . . . *Eight* $845 *and up, f. o. b. Lansing*

OFFICE

WORKSHOP

ALL-PURPOSE

(Upper photograph) Graflexed by L. D. Harris

(Lower photograph) Graflexed by Charles Willey

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GRAFLEX *Cameras*

COLOR FILTERS IMPROVE PHOTOGRAPHS

(Continued from page 72)

happen that the light value of both the sky and the house are the same, and the house lines will fade into the sky.

With panchromatic film in your camera and an equipment of filters, you can decide for yourself whether you want the sky brighter than the house or the house brighter than the sky. The same problem may occur in photographing flowers against various kinds of backgrounds or in mixed groups. Filters will enable you to make the flowers stand out from each other.

OF ALL the photographic filters available, the plain yellow filter is most common. These have been supplied for years in various strengths and graded as "light," "medium," or "dark." They increased the exposure with the film then available two or three times for the "light" grade, five times for the "medium" yellow, and about ten times for the "dark." These filters only absorbed a relatively small proportion of the total amount of light, but the blue and violet rays they took out were just the rays to which orthochromatic film is most sensitive, hence the greatly increased exposures.

Modern panchromatic film also is sensitive to blue and violet light, but in addition it is sensitive to light of all other colors clear to the deep red end of the spectrum. You are no longer restricted to yellow filters. Any color may be used that conditions call for.

High-grade yellow filters made of optically ground yellow glass are obtainable from several makers, but glass of other colors is expensive and hard to get. The finest color filters, such as those used by photo-engravers for the exacting work of making color-printing plates and for other precision color filtering, are made from specially prepared and stained sheets of gelatine cemented between thick pieces of optically perfect glass.

These "A" grade filters are far too expensive for amateur use. Fortunately, however, the same grade of stained gelatine in thin sheets 2 in. square can be obtained for about fifty cents apiece in any color. They do not fade or change color with exposure to light, but being nothing but plain gelatine, they are mechanically delicate and must not be handled with the bare fingers or allowed to come in contact with moisture.

Theoretically, the best place for a gelatine filter is between the front and rear sections of the lens next the iris diaphragm. For experimental use, this is an unhandy method. Front mounting is the only practical way for amateurs to mount filters.

ONE of the photographs shows an excellent experimental mounting that holds three filters and slips into a 2-in. carrier attached to the lens. Three 2 in. square gelatine filters are mounted, without cutting, between two pieces of stiff, thick cardboard through which holes have been cut slightly larger than the lens with which the filters are to be used.

Cutting smooth round holes with a penknife through thick cardboard is tough work. If an expansion bit is available, the job can be done easily and quickly by clamping the layers of cardboard between two boards and boring the holes straight through.

Mounting is simple. The gelatine squares are laid over the holes in one cardboard, the other cardboard is placed over them, and the two cards are tightly held while the edges are bound with black lantern-slide tape or strips of the proper width cut from ordinary gummed paper sealing tape. When not in use, each filter unit can be kept in a slip envelope made of strong manila paper.

You can buy a filter holder that will take 2 in. wide filters and attaches to the lens by spring clips, or you can make a simple carrier out of sheet metal or cardboard.

A good combination of filters for most amateur requirements would consist of two units of three filters each. Fit one with the tricolor filters known as Wratten A (red), B (green), and C5 (blue). Fit the other with X1 (light green), G (deep yellow), and F (deep red).

A detailed description of all the possible useful applications of filters would fill a large book, but the principle, as already stated, is simple. You use a filter to emphasize certain objects in the picture or to change the relation between two or more objects.

Suppose, for example, you wish to take a distant scene on a day when the sky is overcast in a uniform gray and the distant portion of the view is enveloped in a slight mist. Without a filter the resulting picture would hardly be worth taking.

Try shooting such a view with the G (deep yellow) filter in front of the lens. With supersensitive panchromatic film, the exposure will have to be increased only about three times (one and one half diaphragm stops), and the distant portion of the view will be brought out in a way that will surprise you.

With high-speed orthochromatic film, the exposure with this filter would have to be increased twenty-four times, a figure that will indicate to old-time amateurs who have not yet experimented with the new panchromatic film just how color sensitive it is.

If conditions are very bad or you are most interested in bringing out the details of distant buildings, try the A (red) and increase the normal exposure by four and one half times, or use the F (deep red) at ten times normal. These will bring out details almost invisible to the naked eye.

On days when the air is clear and the sky intensely blue, these same filters will produce amazing effects. G will cause fleecy clouds to stand out like fluffy cotton; A makes the effect still more pronounced; and using F and at the same time underexposing a bit, will give you weird moonlight effects, especially on snow scenes.

The illustrations at the bottom of page 72 will give you an idea how filters may be used to change the appearance of objects. The first was taken with supersensitive panchromatic film without any filter. The others were taken with the tricolor filters A, B, and C5 respectively. No changes were made except to increase the exposure according to the filter factor. Note how radically different the various items on the table appear in these views. In fact you can, knowing which filter was used for each view, easily figure out what the actual color of every object in the picture must be!

Our winter series of four photographic contests proved unusually successful both in respect to the number of entries and their quality. The winners of the December contest are listed on page 103. The November awards were announced last month, and the January and February contest winners will be published in the May and June issues.

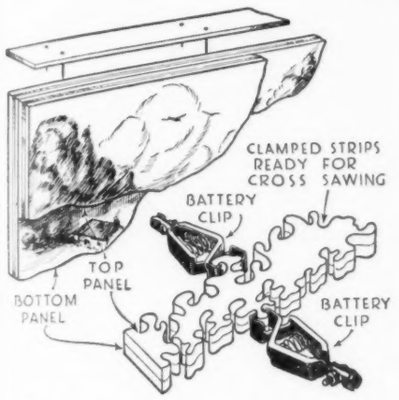
COLORING NEW PUTTY

WHEN a new window pane has been put in, the putty can be colored by dusting a dry (powdered) color over it. The oil in the putty absorbs the color, and this can be done at once without waiting for the putty to dry before painting it.—D. H.

SAWING TWO PICTURE PUZZLES AT ONCE

TWO picture puzzles may be jig-sawed at one time if the proper saw blades are obtained. An average of 250 pieces an hour is possible, as much time is saved in both the sawing and assembling operations.

One should use what are commonly known as "double-tooth skip" blades having 33 teeth per inch. These saws are slightly stouter than some of the lighter ones, being almost .008 in. in thickness. As a consequence, puzzles made with them will be a



The puzzles are held at first with cardboard strips, then with small spring battery clips

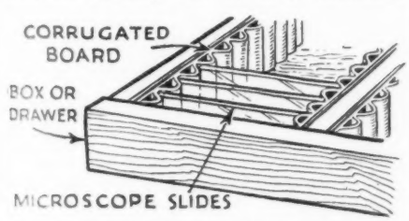
trifle looser, and more care should be exercised when sawing the interlocking keys. The blades will, however, turn sharply.

The two panels must be the same size. Strips of cardboard slightly narrower than the combined thickness of the two panels should be tacked to the edges with short, fine brads, bank pins, or small wire staples. Drive the points into the center cores to avoid separating the plies.

After the combined panels have been halved or quartered, the sections will not be securely held by the cardboard strips and it is impractical to continue by this method alone. Obtain at least four small spring-clip battery connections. By hooking several of these over keys around the edges, no slipping can occur even while you are sawing strips or small pieces. When the strip or section has been completely sawed, remove the clips and drop the mass into place.—W. L. FAUROT.

EASILY MADE BOXES FOR MICROSCOPE SLIDES

NOT having the facilities for making a wooden filing box for microscope slides, I devised the easier method of construction illustrated. Corrugated cardboard such as is used for packing and in some cardboard



Single-faced corrugated packing boards used as grooves for filing away microscope slides

boxes provides the grooved guides for filing away the slides. These guides are merely glued in cardboard or wooden boxes of suitable sizes. They can be packed out if the box is too wide, or they can be set crossways in a narrow box.—ROBERT BARTLETT.

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ROYAL PORTABLE TYPEWRITERS

"WHY LEAVE HER IN A FEVER?"

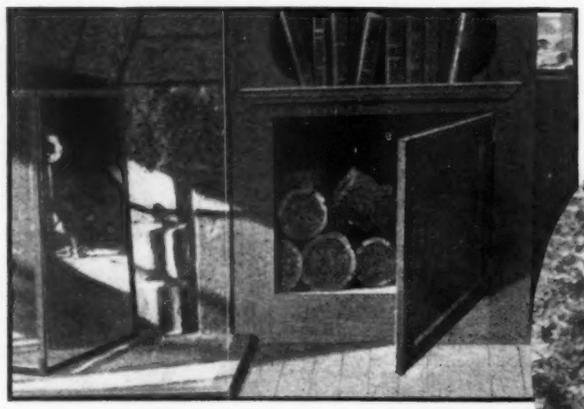
ONCE she hungered for his morning good-bye kiss. But lately the smudge from that venomous chimney leaves her hungering only for plenty of fresh air.

He can keep his bride and keep his briar—with a little consideration for them both. Ream out the old pipe, friend! Ram a cleaner through the stem. Fill up with Sir Walter Raleigh. And settle down to a second honeymoon. This mild mixture of Kentucky Burleys is a cool-burning, slow-burning, well-aged tobacco that is indescribably milder. It has brought families and friends closer. It certainly is bringing a new favor to indoor smoking. And making quite a reputation for itself on the way. Try it!

Brown & Williamson Tobacco Corporation
Louisville, Kentucky, Dept. Y-11.

Send for this
FREE
BOOKLET

It's 15¢—AND IT'S MILDER



The log compartment is in the base of a bookcase beside the fireplace, and it has an outside door, as illustrated in the oval

FIREPLACE LOG CHEST HAS OUTSIDE DOOR

BY STORING fireplace logs in a wall opening like that illustrated, the maintenance of a glowing, cheerful fire is made easier and much dirt in the house is prevented. An ordinary large steel ash-pit door and frame is used on the exterior of the wall and cemented in with a mixture of 1 part cement and 2 parts sand.

To make the room side of the wall attractive, an open bookcase may be constructed as shown. The interior door should be hinged on the far side of the opening so that the door, when opened, will not interfere with transferring the logs from the chest to the fireplace. If the base of the bookcase is made sufficiently large, a place may be reserved for newspapers or small kindling.

A good lock should be placed on the interior door to discourage intruders from gaining access to the house. A lock on the exterior door ordinarily would not be satisfactory for the reason that one would have to get the key and unlock the door whenever logs are to be placed in the chest. The exterior door should be painted the same color as the wall exterior.

In a house under construction, little time is required to provide such a log chest. In a constructed house, however, a good cold chisel is necessary to cut the hole through the wall. After one or two bricks have been taken out, the rest can be removed easily.—EARL E. MOORE.

REUPHOLSTERING OLD CAR

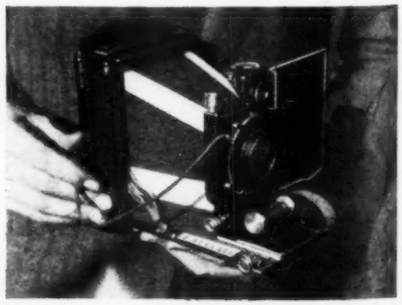
IF YOUR car needs reupholstering, you may obtain suitable material from an auto junk yard at low cost. The leather seats and backs of large cars are best; they are of good quality and may be trimmed to fit a smaller car. Be sure the leather you buy is not too old or dried out.

The old upholstery may be removed entirely except the springs since the padding will be attached to your new material. In the repair illustrated, the back was simply tacked to the wooden frame, and the seat was sewed on at the bottom, as it was an all-metal frame. The entire repair was made with genuine leather for less than $1.50 plus a few hours' work.—J. D. STAGGS.

BELLOWS SHIELD AIDS IN AERIAL PHOTOGRAPHY

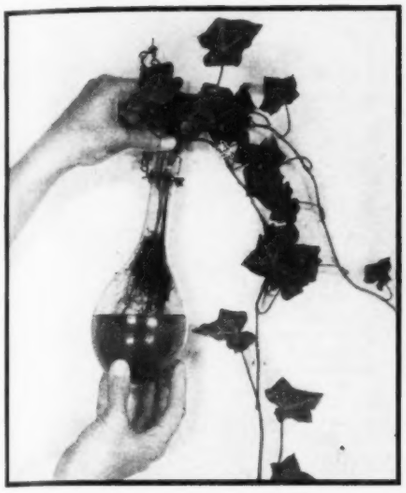
THE next time you make a trip by plane, take your camera up with you. Excellent aerial photographs can be made with amateur cameras by adding a bellows shield to prevent the bellows from collapsing in the propeller blast.

A simple homemade shield that incloses the bellows from the body of the camera to the lens front is sufficient, providing it affords complete rigidity. To remove or install the shield, the lens front is pulled out, and the shield then slips readily past. The parts are cut from stiff cardboard and hinged together with medical adhesive tape.—ARMISTEAD WHARTON.



The shield is of a size to stay rigid when the lens front is in the infinity position

ANTIQUE BOTTLE HOLDS GROWING IVY PLANT



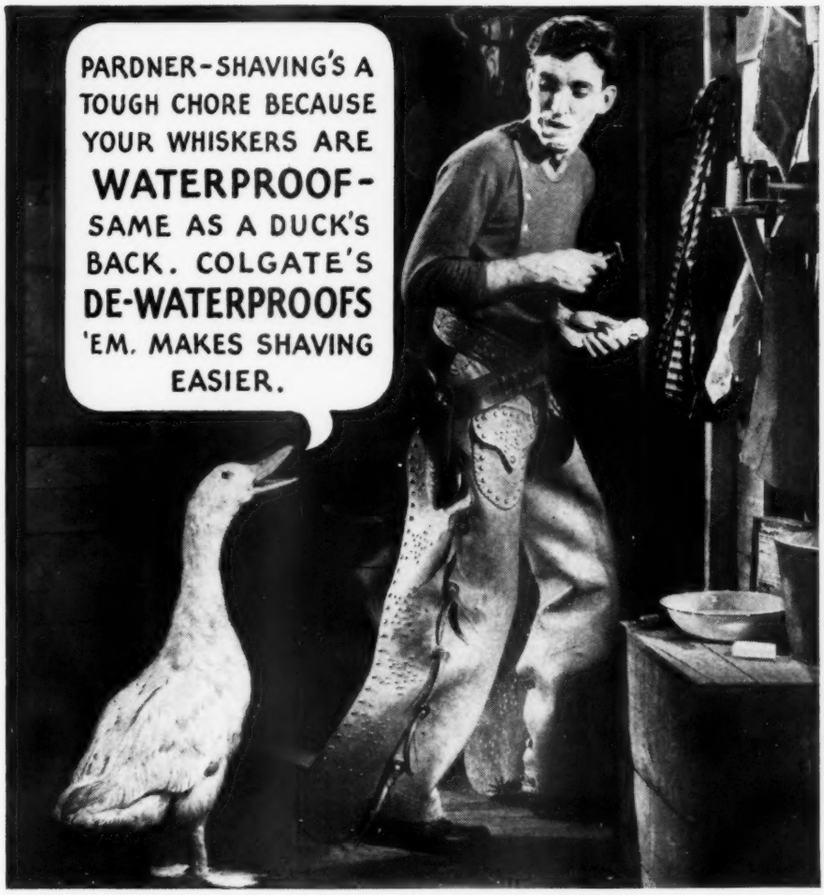
AN OLD-FASHIONED one-pint demijohn of the round-bottom variety makes an antique-looking and exceedingly picturesque wall receptacle for an ivy plant. Bottles of this variety are found in many homes or may be purchased at most antique shops for about half a dollar. Fasten one end of a brass chain tightly around the neck of the bottle and form a loop in the other end of the chain.

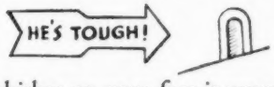
Place in the bottle an English ivy with most of the soil removed from the roots, or any indoor plant that will thrive in water. Fill the bottle with water and hang it in the sunshine on the window frame in the living room or in the sun parlor. The trailing plant hangs gracefully over the green-tinted glass.—GEORGE A. SMITH.

SANDPAPER BLOCK FOR RABBETED EDGES

RABBETED edges can be sandpapered easily with the aid of a holder made from two blocks of wood. The blocks are placed against the surfaces of the rabbet as shown below and then fastened together with a screw at each end. The screws are loosened for inserting the sandpaper, and retightened. This tool will do a clean-cut job.—GEORGE E. KILPATRICK, JR.

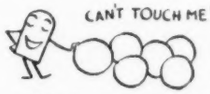
A two-piece sanding block that saves time and insures a good job in smoothing rabbets


PARDNER-SHAVING'S A TOUGH CHORE BECAUSE YOUR WHISKERS ARE WATERPROOF- SAME AS A DUCK'S BACK. COLGATE'S DE-WATERPROOFS 'EM. MAKES SHAVING EASIER.



Every whisker on your face is wrapped in a tough, waterproof coating of oil that makes it hard to cut.

Once you remove every trace of that waterproof coating from every whisker, you get a shave as smooth as a barber's second time over.



But the trouble is—most shaving creams won't, *can't* remove *all* the waterproofing. Most shaving creams froth up into big bubbles—and you can't get a *lot* of *big* bubbles *close* around every whisker.

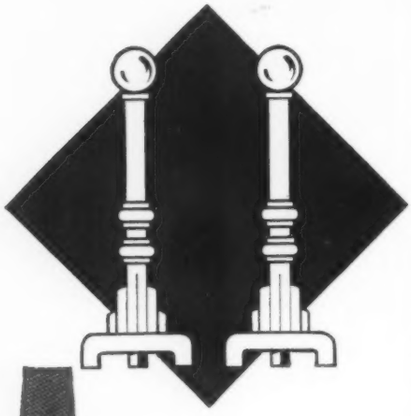
But Colgate's Rapid-Shave Cream whips up into millions of tiny *little* bubbles.

Thousands of these tiny lather bubbles go to work on every single whisker you own. They crowd *close* to it. They completely surround it . . . strip every trace of waterproofing from it. These tiny bubbles *emulsify* that oily, waterproof coating—and wash it completely away.

Then they soak each whisker so soft that your razor slips through it like a knife through butter. Try Colgate's and see for yourself how much easier the *small bubble lather* makes your daily shave. The large 35¢ tube is now only 25¢—buy it today.

P. S.—For a perfect wind-up to a Colgate shave, try Colgate's After-Shave Lotion and Colgate's Talc for Men.

WORK IN METAL *with* NICHOLSON FILES



THE home craftsman whose shop is adequately equipped with Nicholson Files need not limit his work to wood.

Strap hinges, andirons, to quote two instances, can be made with the help of Nicholson Half Round and Flat Bastard Files.

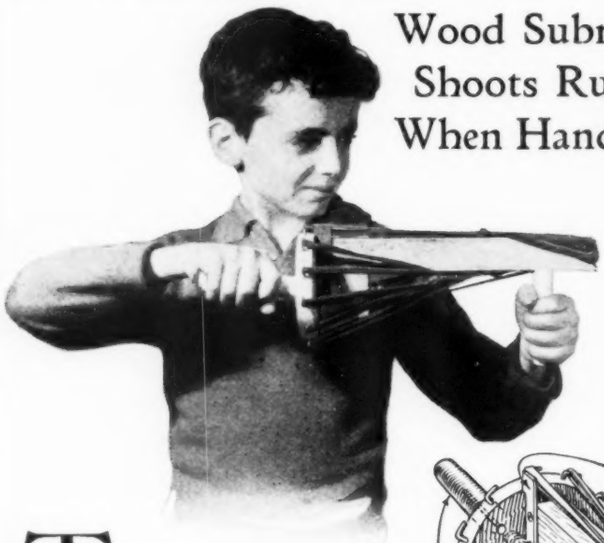
Work in metal with Nicholson Files—with Nicholson Files in preference to other brands because the Nicholson Brand is admitted by experts the world over to stand for the most value for the money — for the sharpest, most durable, most uniform files — the file that gives you the best results.

At hardware stores and mill supply dealers. Nicholson File Company, Providence, Rhode Island, U.S.A.

NICHOLSON USA — *Genuine* NICHOLSON FILES

A FILE FOR EVERY PURPOSE

Wood Submachine Gun Shoots Rubber Bands When Handle Is Turned

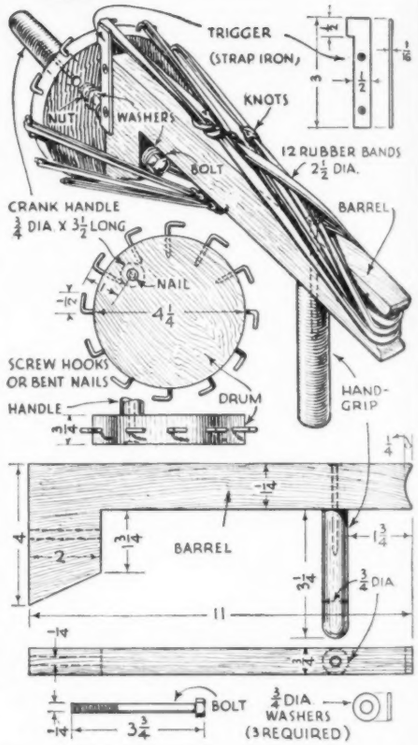


As the drum is turned, each rubber band is brought up against a trigger which pushes it off so that it flies forward with a good deal of accuracy and force. The bands are cut from an inner tube

THIS submachine gun for children shoots rubber bands about 2½ in. in diameter cut from old inner tubes. The width of the bands depends upon the strength of the child. Those shown are quite wide and fly with surprising force. Thinner bands are easier to load and safer. Of course, the gun can also be made to shoot bands of smaller or larger diameter by lengthening or shortening the barrel.

The drawings show the construction, but be sure to build the gun strong enough to stand the considerable strain caused by loading it. Put a drop of glue on each screw hook before inserting it into the wooden drum, otherwise the hooks will turn under the tension of the bands.

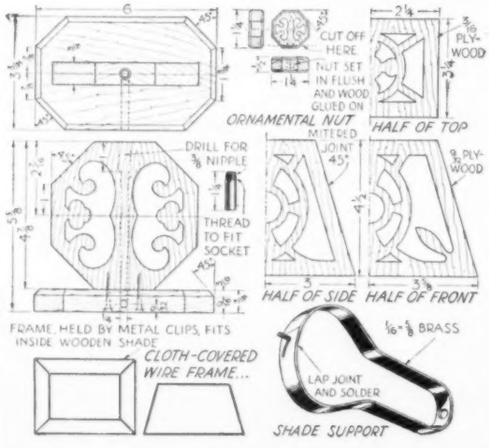
To load the gun, a band is hooked on the topmost of the twelve hooks and stretched to the groove at the end of the barrel. Then the drum is turned to the left until the next hook is on top, and another band is put on. When twelve bands are on, the gun is ready for action. In shooting, the drum is turned to the right.—GEORGE PLUNGAS.



JIG-SAWED LAMP AND SHADE

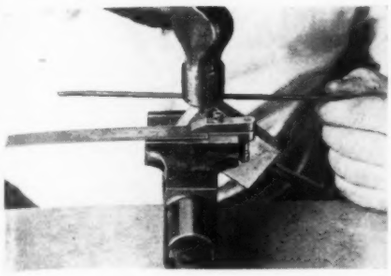
ORNAMENTAL lamps of many types may be made by the owner of a motor-driven jig saw. A sample of such a lamp is shown in the accompanying photographs and drawings. It was designed and constructed by Robert Putzer, of Oshkosh, Wis., and won a prize in our last jig-sawing contest.

Complete lamp, separate parts, and drawings



Ⓢ This seal on an advertisement signifies the approval of POPULAR SCIENCE INSTITUTE OF STANDARDS.

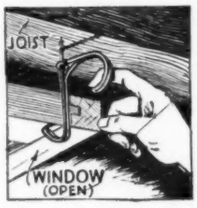
HOW TO CUT HEAVY WIRE INTO SHORT PIECES



The wire is cut on the corner of a hardened steel block, and the scale serves as a gage

WIRE that is too heavy to be cut by pliers can be handled conveniently in the manner illustrated above. Take a square block of hardened steel with sharp corners, tighten the end of a scale in a small clamp, and grip both together in the vise. Have the end of the scale in line with the corner of the block. Standing over the job, you will find it quite easy to see when the end of the wire is in line with the required measurement, and a blow with the hammer will then cut off the piece. If the wire is not cut entirely through, it will break off when bent. For a number of pieces, this set-up saves time.—H. MOORE.

A QUICK-ACTING CATCH FOR CELLAR WINDOW



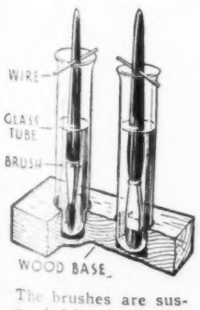
Coat hook used as a cellar window catch

THE automatic cellar window catch illustrated, which is made from an ordinary wire coat hook, is an improvement over the usual hook and eye and other homemade wire fasteners used for this purpose. It is also useful on certain storm or other windows of a similar type because it is positive in action and easily released.

Bend the end of the hook as shown and screw the hook at the proper place on the joist or ceiling to catch the window when swung open. The hook is screwed in for about half of its thread length into the joist, to leave it semiflexible. The raised window is released by a pull.—BRADFORD CHENEY.

MULTIPLE HOLDER KEEPS SMALL BRUSHES CLEAN

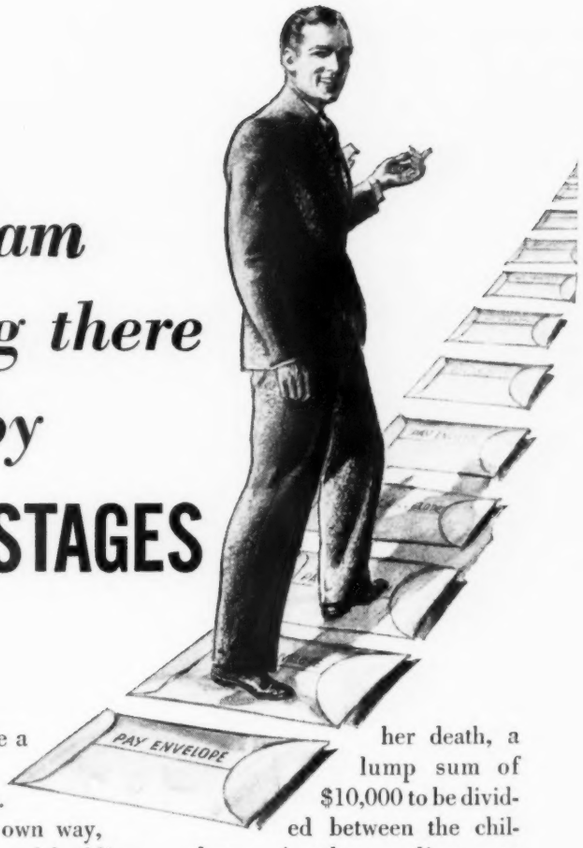
FOR cleaning or keeping soft the type of artist's brushes used in painting ship models and other small work, I use the glass tubes in which certain toothbrushes are sold. Common test tubes would do as well. The tubes stand upright in holes in a block of wood. If the tubes happen to be oval, enlarge the holes.



The brushes are suspended in glass tubes

The brushes are suspended in the cleaning fluid or turpentine in such a way that the bristles are just off the bottom. This is accomplished by slipping a short piece of wire through a hole drilled in the handle of each. These wires may be set in holes in the base when not in use.—G. D. GIRARDET, JR.

I am getting there by EASY STAGES



"Nobody left me a fortune," said Charles Tompkins. "I'm making my own way, meeting expenses, and building financial *independence* for my family and myself.

"An Equitable agent showed me how I could get there by easy stages simply by putting into life insurance a part of my weekly salary—an amount that I can well afford.

"The Equitable considered my family needs and my own ambitions; then worked out a program that exactly fitted my requirements.

"One policy will provide funds to send my two boys through college. Another will provide a life income of not less than $60 a month to my wife; on her death, a lump sum of $10,000 to be divided between the children. Another policy was planned to pay $2000 to clean up my last bills and expenses. And notice this: When I reach age 60, the policies can be used to give my wife and myself a comfortable retirement income for as long as we live.

"When I tell you that I'm securing all these benefits for an average of about $13 a week, you will understand what I mean by 'getting there by easy stages.'"

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FAIR — JUST
LIFE ASSURANCE
SECURITY — PEACE OF MIND
SOCIETY
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The EQUITABLE Life Assurance Society of the United States 56 P.S.
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I am interested in your "Case Method" of adapting life insurance to specific needs. Kindly mail explanatory booklet.

NAME .....

ADDRESS AGE

NEW

for INDOOR TARGET SHOOTING

the first .22 cartridge that **CUTS A CLEAN HOLE**

LOOK IT OVER, fellows. Here's a target cartridge that cuts *clean* every time you shoot. No guessing where the bullet went. There, right before your eyes, is a neat, round hole. No cracks, no jagged edges. And that means *easier spotting and faster, more accurate scoring.*

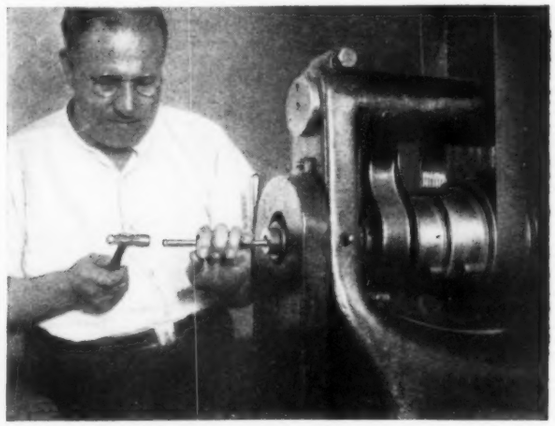
This new .22 sharp shoulder cartridge has been designed specifically for indoor target shooting. It has the same fine accuracy that distinguishes the Remington .22 Long Rifle line. It is Hi-Speed, loaded with smokeless powder in a brass shell. And it's Kleanbore—no leading, no pitting, no rusting, NO BARREL CLEANING!

Try these new sharp shoulder target cartridges. See the difference they make in spotting and scoring your targets. Your dealer has them. Just ask for the new Kleanbore .22 Long Rifle Target Cartridge with the new sharp shoulder bullet. Remington Arms Co., Inc., Bridgeport, Connecticut.

Remington DUPONT

KLEANBORE AMMUNITION

REMOVING A TIGHT MILLING ARBOR



Even a badly stuck arbor can be removed with a slightly kinked brass rod and a small hammer without causing damage

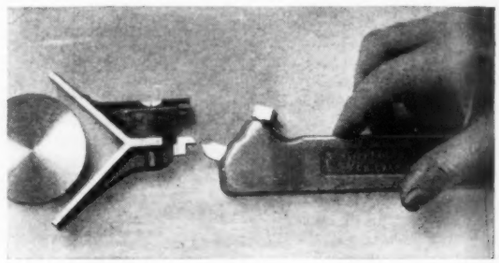
THE ordinary method of removing stuck milling arbors is to drive them out with a heavy rod; but if an arbor has been in a long time and has rusted a little, it is sometimes next to impossible to get it out without battering the tang and otherwise injuring it. The difficulty is further aggravated by striking the driving-out rod with a heavy hammer, which damages spindle and bearings as well as the arbor.

A far better way is to use a brass knock-out rod about ½ in. in diameter. This should be bent slightly in the middle, and then straightened enough to leave a small kink. After it has been inserted, it should be struck a succession of sharp blows with a hammer weighing about 8 ounces. The rod, being small in diameter, springs slightly, but this tendency is limited because the kinked part strikes the bore of the spindle. Two or three minutes of this treatment will loosen the worst arbor.

Some arbors are provided with a nut to take them out, but this is not always effective; and an arbor has been removed by the method just described after the threads in the nut had been completely stripped.

Lathe centers may also be removed in this manner when they will not readily yield to any other treatment.—G. J. M.

CENTER FINDER FOR LATHE



IN TURNING on the lathe, much time is usually lost in setting the bit so it will produce a clean cut without undue wear on the tool. Furthermore, different metals require a variation of the position of the bit in relation to the center. For instance, in turning steel, the work can be accomplished with the greatest efficiency when the cutting edge of the tool is just above the center. Cast iron, however, is usually turned with the tool as near to the center as the operator can guess, while brass will cut cleaner and with less tendency to chatter when the cutting edge is a little below the center. In facing work it is particularly irritating when the finishing cut leaves a small projecting nib at the center because of the wrong setting of the tool, especially as this indicates that for a considerable distance from this the work is not perfectly flat.

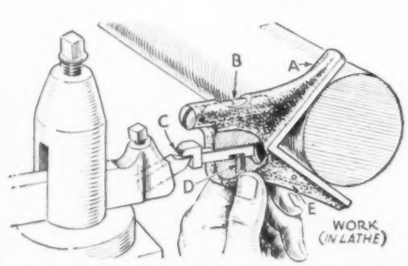
To minimize these difficulties, some workmen set the tool point by the headstock center, but this is not always either convenient or practicable. In some instances it does very well until it is necessary to grind the tool, and then the machinist is at sea again with only his well-worn guess compass for a guide.

As a remedy for this, the device shown below was devised. It is composed essentially of a 90-deg. V, a spirit level *B*, and a sliding bit abutment *C*, together with a spring *E* and stop screw *D* that limits the movement of the abutment and tends to keep it in an outward position. The outer end *C* of the abutment is so constructed that its lip is exactly on the center line that is assumed to pass through the corner of the mouth *A* at the apex of the angle.

It will now be seen that if the angular opening is placed against a round body—for instance, the tailstock spindle or a chuck on a lathe—the cutting point of the tool bit may be set precisely on the center of work in the lathe by adjusting the holder in the tool post until the bubble *B* of the level is central with a line etched on the glass. If it is desired to set the tool below the center, the outer edge of the bubble is made to come into alignment with the line. For steel, the tool point is adjusted to raise *C* above the center until the inner edge of the bubble is even with the line.

In constructing this bubble center finder, the position above and below the center for the different metals was experimentally determined so as to obtain the best results with the least wear on the tool-bit cutting edge, and also to enable quick and handy manipulation in setting, by the pressure of the bit upon the heel of the abutment beneath *C*, which causes the mouth *A* to press against the work by recession of the spring *E*.

The device will accurately center any job for turning or facing from ⅛ in. to 1 ft. or more in diameter, and has been found to be a time saving accessory for use with the lathe.—GEORGE J. MURDOCK.



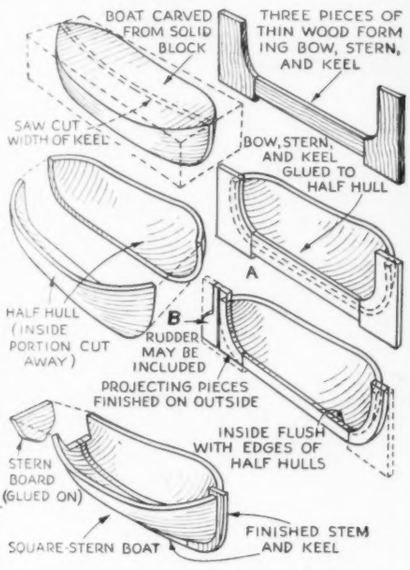
The center finder broken away to show how it is slotted for the tool gage and spring

IF THE tiny retaining screw in a door-knob persistently works loose, put a drop of shellac on the threads.—E. S.

CARVING SMALL BOATS FOR SHIP MODELS

SMALL boats for ship models are usually carved from a solid block. Better results can be obtained with less chance of splitting the ends by the method illustrated. I have a 2½-in. whaleboat that was carved from white pine to less than 1/16 in. in thickness.

Cut a block to the greatest dimensions of the boat with an allowance for saw cuts and sanding. Neglecting all details such as rubbing strips, moldings, keel, stem, and sternpost, mark the plan on the top; and, on the side of the block, mark the vertical section through the keel. Carefully draw a fore-and-aft center line extending entirely around the block. Saw out the shape of the boat on the plan and profile lines, round the bottom to shape, and carefully finish the lines of the


BOAT CARVED FROM SOLID BLOCK
THREE PIECES OF THIN WOOD FORMING BOW, STERN, AND KEEL
SAW CUT WIDTH OF KEEL
BOW, STERN, AND KEEL GLUED TO HALF HULL
A
HALF HULL (INSIDE PORTION CUT AWAY)
B
RUDDER MAY BE INCLUDED
PROJECTING PIECES FINISHED ON OUTSIDE
INSIDE FLUSH WITH EDGES OF HALF HULLS
STERN BOARD (GLUED ON)
SQUARE-STERN BOAT
FINISHED STEM AND KEEL

When shaped on the outside, the block is cut into two halves, which are easier to hollow

gunwales. As the center lines are cut away, renew them, being careful to do so before they are entirely lost.

Turn the hull bottom side up and, with a coping saw, carefully make a cut the width of the keel all around the center line. Carry this cut through until the hull is divided in half. With a small gouge and sandpaper, work the halves of the hull down to the desired thickness.

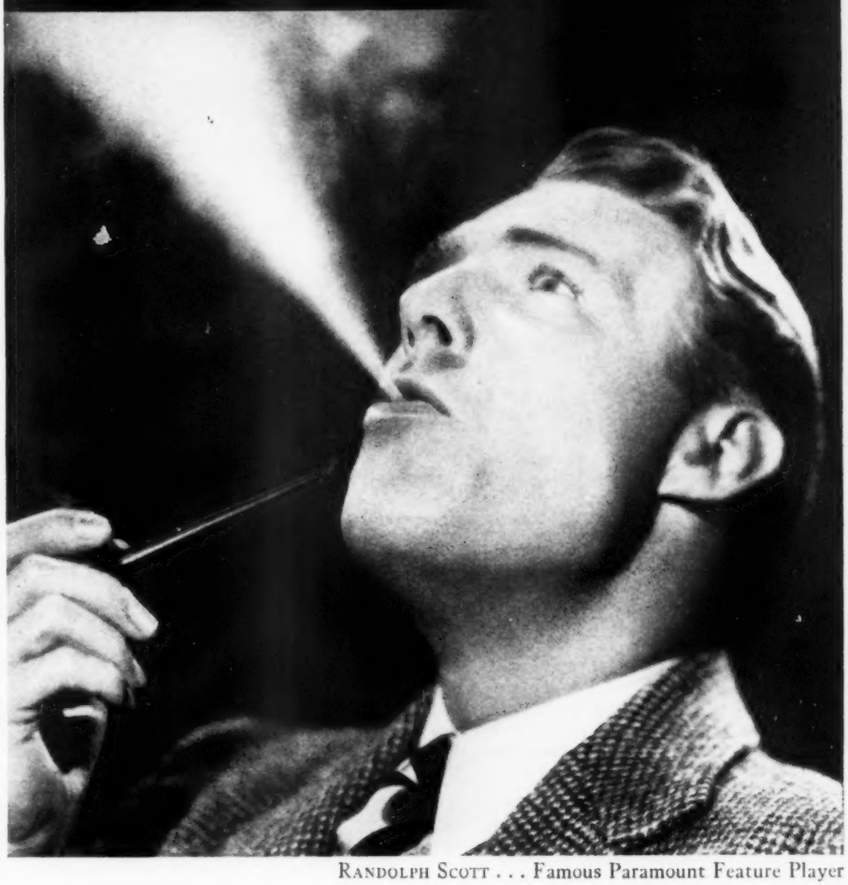
Wood of proper thickness is now glued to one-half of the hull along the saw cut as at *A*. This should be in three pieces, cut so as to eliminate the weakness of cross grain. After the glue is set, these pieces are finished flush with the inside of the hull, and the other half hull is glued in place. The centerpieces projecting on the outside are then finished to shape as shown.

In square stern models, the part representing the stern boards is cut away when hollowing the halves of the hull. When all inboard details are completed, a piece of thin wood is glued across the stern and shaped to the hull.

A rudder may be in one piece with the sternpost by representing the dividing line with a V-cut filed along the proper line as at *B* before the parts are assembled.

Molding or beading, rubbing strips, and the like are made of thin strips of Bristol board glued in place. Depending on the scale, Bristol board or thin wood is used for seats and other inside details. Paint should be applied in thin, clean-cut coats with a small brush.—G. I. JOHNSON.

"I'm a push-over for fine Tobacco"



RANDOLPH SCOTT . . . Famous Paramount Feature Player

FINE tobacco is a weakness of mine. And often I'm tempted to try the most expensive kinds. But fine tobacco, I've discovered, isn't necessarily high priced.

For steady smoking, I like Union Leader. Its smooth, well-matured Kentucky Burley never tires my taste; it's so fragrant, full-flavored and biteless.

Don't let that 10¢ price mislead you! It's hard to beat the satisfying qualities of Union Leader, at any price. (Great for cigarettes, too.)

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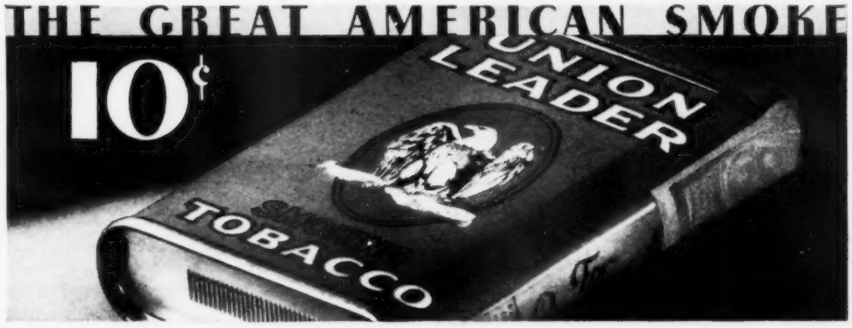
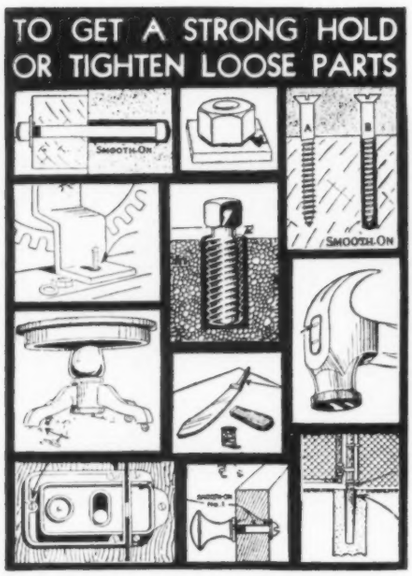
UNION LEADER

THE GREAT AMERICAN SMOKE





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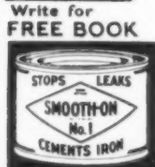

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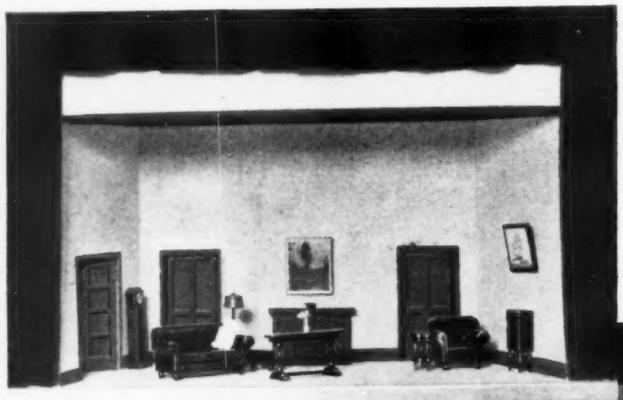
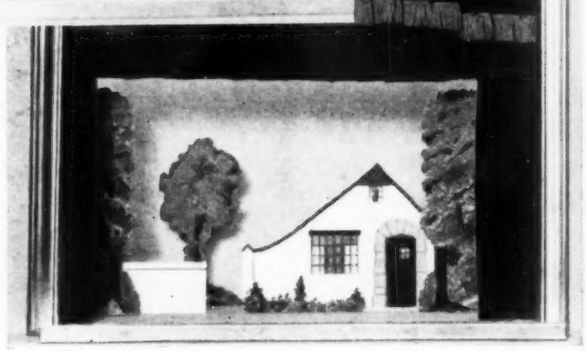
HOW TO LIGHT YOUR MINIATURE STAGE

(Continued from page 76)

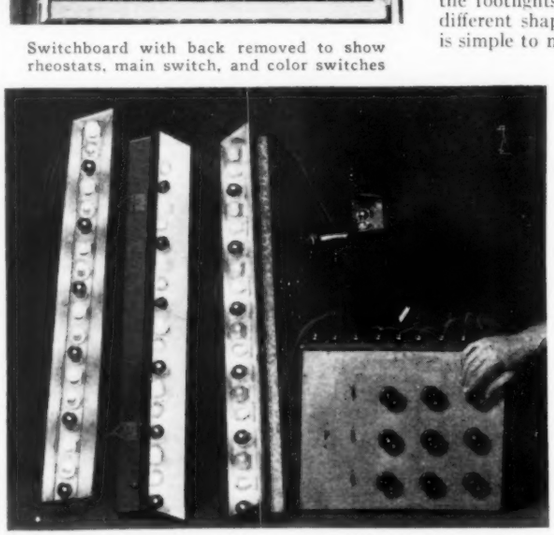


The walls of the interior set are cut out of a single piece of wall board as shown in a drawing near the end of this article. Toys repainted brown are used as furniture. The outdoor scene below contains a house of pressed wood composition board and trees cut from wall board



be constructed so as not to obstruct the view from the front. They are made as follows: First, bend the trough as shown in the drawings from a piece of galvanized iron 36 by 12⅛ in. Make the ends and solder them in place. The 36 in. long inside strip for holding the sign sockets is next made. Be sure it fits properly before inserting the sockets. Remove the retaining rings from the sockets and fasten them in place, making certain the sockets will not turn. Wire every third socket as shown in one of the photographs, using asbestos-covered wire. When all three circuits are wired, solder all terminals so there will be no loose connections.

Switchboard with back removed to show rheostats, main switch, and color switches



Footlights, border lights, flood light, and switchboard with four switches, rheostat knobs, and receptacles in edge

Tape the wires where they come through the tin, and use insulating bushings to keep the tin from cutting the wire.

With the light strip in place, drill four holes through the trough and through the edge of the light strip, being careful not to hit the sockets and wire with the drill, and fasten in place with ¾-in. sheet metal screws, which will cut their own thread as they are screwed in. Instead of using the screws, you may solder the strip in place. Next solder small hangers so that the footlights will not fall through the hole made in the floor of the stage when the trough is set in place. A strip cut from the stage floor about 4 by 36¼ in., as close to the front as possible, is necessary to set the footlights in.

The border light (see drawing) is hung from the top of the stage. It is made like the footlights, except that the trough is of a different shape. The small flood light shown is simple to make and will be useful for lighting scenes from the side, as well as for special effects.

The switchboard is made of white pine lined with ⅛-in. asbestos board. The front and back panels are made of asbestos wood ¼ in. thick. The box is 4 by 13½ by 17 in., and the front and back are each 13 by 16½ in. The switches and rheostats are mounted directly on the front panel. The receptacles supplying current to the different pieces of equipment are mounted in the top edge of the box. These receptacles can be purchased at the ten-cent store and are the type used for floor plugs. They are installed through holes 1⅛ in. in diameter. All wiring is inclosed. The back should be drilled full of ¼-in holes for proper ventila-

(Continued on page 87)

HOW TO LIGHT YOUR MINIATURE STAGE

(Continued from page 86)

List of Materials

54 Intermediate base sign sockets ($6.48).

54 Intermediate base S-11 sign lamps, 10 watts, 110 volts, in colors as follows: 18 red, 18 blue, 18 clear or amber ($13).

4 Toggle switches of type illustrated ($1).

9 Receptacles and plugs ($1.35).

9 Rheostats, each 110 volts, 60 watts ($15.34).

60 ft. No. 18 asbestos-covered wire for inside of footlights and border lights; 15 ft. No. 14 asbestos-covered wire for inside of switchboard; and 75 ft. No. 18 lamp cord to carry current from switchboard to borders and footlights ($2).

3 Insulating bushings ¾ in. in diameter and 1 bushing ½ in. (10 cents).

Wood for switchboard: 2 pc. ¾ by 4 by 17 in., and 2 pc. ¾ by 4 by 13½ in. (10 cents).

Asbestos wood for switchboard: 2 pc. 3/16 in. by 13 by 16½ in. (78 cents).

Tin, No. 26 gage: 3 pc. 36 by 2¾ in. for socket strips; 2 pc. 36 by 11¼ in. for making border trough; 1 pc. 36 by 12⅛ in. for footlight trough; 1 pc. 12 by 15 in. for ends ($3, including bending).

Solder (10 cents).

Paint: Flat white for inside reflectors; flat black for outside switchboard and borders; color to match stage floor for outside footlights.

NOTE: The prices in parentheses are what the author paid in Omaha, Nebr., and are given only to show the approximate cost. There will be considerable variation depending upon the quality of equipment purchased and local trade practice.

tion, as the rheostats get quite warm when in use for any great length of time. The wiring inside the switchboard should be done only with asbestos-covered wire, and all connections should be carefully soldered. The wiring diagram on page 76 shows how the wiring is done, and one of the photos gives a picture of the switchboard with the back removed.

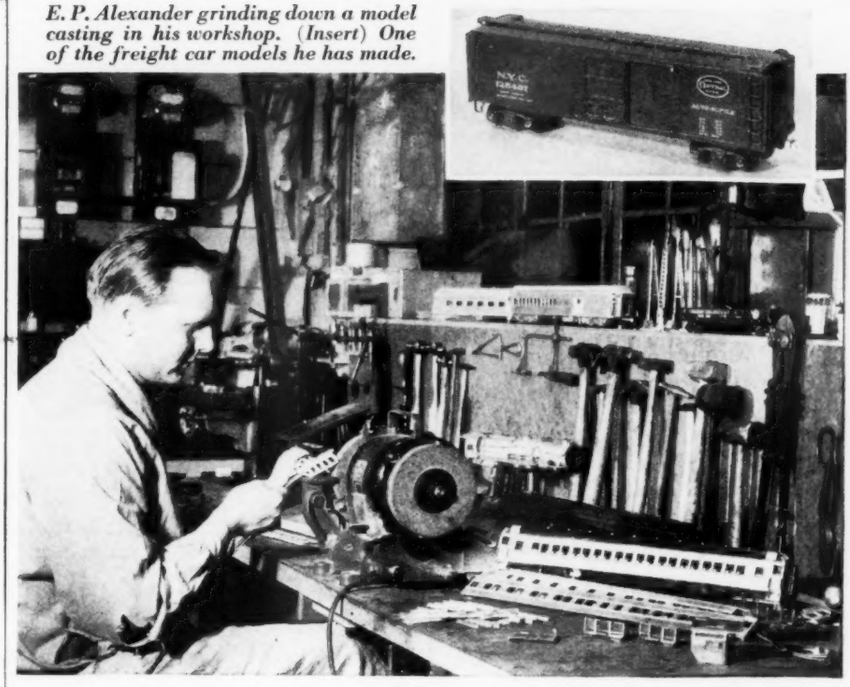
Splice the lamp cord carefully to the proper wires coming out of the border and footlights. Solder each joint, then tape it first with rubber tape and finish with regular friction tape. Next, fasten a regular drop-cord plug on the other end and mark each one. Plug into the switchboard and then plug the switchboard into the house supply. When all lights are on, only 540 watts of electricity at 110 volts are used. A heavy drop cord will carry the load safely. *Never overload the rheostats,* as they burn out quite easily. Never connect more than 60 watts to each rheostat.

The most important thing in regard to stage lighting is the effect of colored lights upon painted surfaces. Because of the lack of pure color in both lamp dyes and pigments, one must carefully consider the action of light on the painting so as not to spoil the effect desired. Blue light on buff, and red on green give a muddy and undesirable color. Because of the variation in color pigments and dyes, it is difficult to describe the effect of lights on painted objects; therefore it is possible only through experiment and experience to obtain the desired results.

On the switchboard, the red, blue, and clear circuits have a separate switch, which can be used to turn out the colors not wanted in any special scene. Another switch is used to control all the lights.

Three useful sets are illustrated—an interior set, a castle set, and an outdoor scene using a simple set house *(Continued on page 89)*

E. P. Alexander grinding down a model casting in his workshop. (Insert) One of the freight car models he has made.



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S. E. 5a World War Plane, 30-in., *168-169*	.50
Single Stick, Tractor, 30-in., *82*	.25
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Canoe, Sailing Outfit, *25*	.25
*Canoe, 16-ft. Canvas Covered Kayak, with sail, etc., *192-193-194-R*	1.00
*Duck Boat, Folding, *170-R*	.50
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*Outboard Racer, 10 ft. 4 in., 114 lb., *211-212*	.50
*Sailboat-Motorboat, Combination (15 ft., cat rig), *131-132-133-R*	1.00
Marconi Rig with Jib for Above, *133A*	.25
*13-ft. Rowboat-Motorboat, *147-R*	.50
*14½-ft. Rowboat-Motorboat, *148-R*	.50
*16-ft. Rowboat-Motorboat, *149-R*	.50
Stern Drive Installation (when used with rowboat-motorboat), *150*	.25
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Screens, Modernistic Folding, *91*	.25
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Smoking Cabinet, *2*	.25
Spanish Mission Armchair, *195A*	.25
Stand, Low Modernistic, *100*	.25
Table, Gate-Leg, *24*	.25
Table, Tavern, *105*	.25
Table, Tilt-Top, Oak (top 20 by 24 in.) *140*	.25
Tea Wagon, *13*	.25

Radio Sets

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Amateur Short Wave Receiver, *155*	.25
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(Construction kits are available for some of these models. See page 96)

Bark, Scenic Half-Model (13½-in.), *108*	.25
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Bottle, Clipper Ship in, *121-122*	.50
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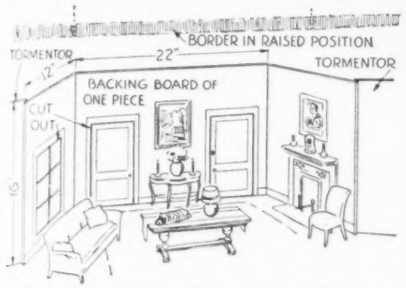
HOW TO LIGHT YOUR MINIATURE STAGE

(Continued from page 87)

and set tree, both being quite easy to make.

The interior set is one of the most interesting to make. The walls are cut from a single piece of wall board, laid out as shown in one of the drawings. The doors are cut out and hung with cloth for hinges. The walls are painted a light tan and spattered with red and blue. The spattering is done by filling a stiff brush with paint and drawing a knife blade across it so as to throw off a spray of small spots. Woodwork and doors should be painted brown. A border is necessary to mask off the top of the set and give the effect of a ceiling. The furniture can be made or purchased at the five-and-ten-cent store and repainted brown. Pictures for the walls



The doors of this set are cut so they can be opened; the window is backed with gauze

may be prepared by mounting old cards and magazine pictures on cardboard and painting a frame of gold or black. Windows in such a set may be cut out and covered on the back with gauze.

The castle set illustrated on page 76 was copied from a picture to show that stage settings may be adapted from illustrations in magazines or catalogues. A blue cyclorama forms the background. The castle and hedge are cut-outs made of wall board. The steps, wall, and posts are made of wood. These pieces are interchangeable with any other set.

The other outdoor scene contains only two new pieces, a set house painted on pressed wood composition board and a set tree of wall board. The other pieces—the "cyc," wall, and wood wings—were used in other sets.

Success in any line of work or play comes from practice. Stagecraft is perfected in the same way. Only by experiment with the miniature stage is it possible to become really efficient in its use.

THIS *is the third and last of a series of articles on building a miniature stage. Additional articles on this and similar topics, including the making of marionettes, will be published if a sufficient number of readers request them. Please indicate what subjects you are most interested in.*

DRILLING THIN STOCK

IT is sometimes necessary to make a true round hole in thin metal stock. Where a punch and die are not available, this may be readily done by clamping the material very tightly between two pieces of wood. First drill a hole in the upper piece of wood the same size as the hole required in the metal. Scribe a circle of the same size on the metal and locate it under the hole in the piece of wood. Clamp tight and drill through. Shim stock .001 in. thick can be drilled by this method; and several pieces can be drilled at a time, or only one as preferred.—W. T. SHERMAN.

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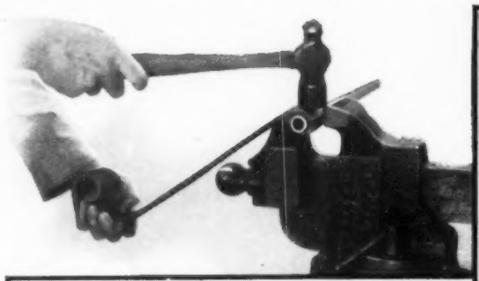
Graceful Candlestick Forged at Low Cost from Band Iron

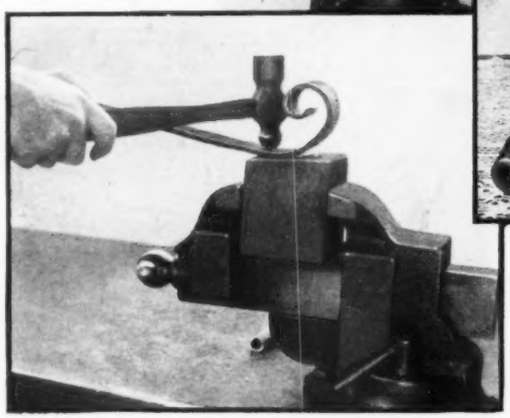
THE use of candles has increased to a great extent during the past few years. While in no way supplanting our modern illuminating systems, they seem to provide just the right atmosphere for intimate, informal gatherings and dinners. The candleholder illustrated is easy to construct and can be made by the home craftsman at very low cost.

The body is made from a piece of band iron ¼ by 1½ by 22¼ in. The ends should be heated and flared to a width of 2⅜ in., as shown at *A* in the drawings. To enhance its appearance, the body should be closely peened with a hammer, as should all of the separate parts before the assembly. After the body has been flared and peened, the length should be about 23¼ in. A slight variation in this length will not affect the general appearance.

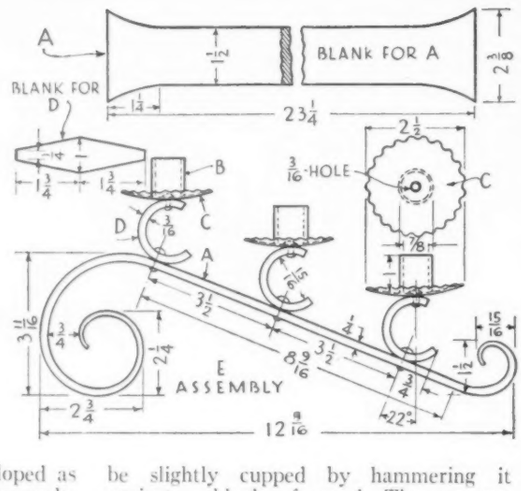
The scroll ends on the body are formed by bending around a piece of pipe and by shaping in the hollow end of a block of wood, as shown in the photographs. The ends of the iron should be heated to a cherry red color before the bending is attempted.

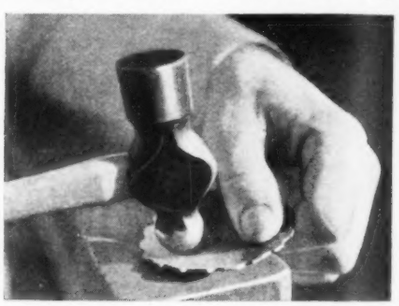
The details of the individual candleholders are shown at *B*, *C*, and *D*. The cylinder *B* is formed around a piece of ½-in. pipe from a blank of 14-gage galvanized sheet iron 1 by 2⅝ in. The joint is brazed or soldered. Since there is a tendency for light metals to expand during the peening process, the piece should be peened and then finished to the size shown before it is formed into a cylinder. The edges of the circular plate shown at *C* should be scalloped as indicated, but do not attempt to make the scallops symmetrical. The plate should be slightly cupped by hammering it against a block of wood. The crescent shaped piece *D* is formed around a piece of 1-in. pipe. The cylindrical piece *B* may be either soldered or brazed to the plate *C*. The individual parts are secured together and to the main body with 3/16-in. iron rivets. The assembly is shown at *E* in the drawings.





Complete candleholder and, at left, how the scroll ends of the body are bent around a pipe and shaped in the hollow end of a block of wood





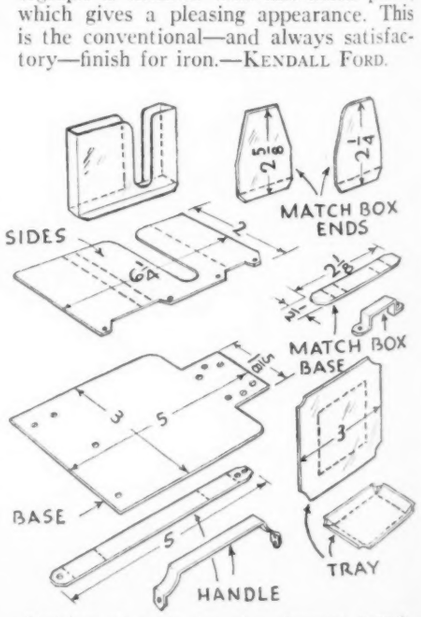
The circular plates for each candle socket are scalloped and slightly cupped. *At left:* An assembly drawing and details of the parts

The completed holder may be finished in a variety of ways, or it may be left unfinished. The holder shown in the photograph is finished with flat black paint, which gives a pleasing appearance. This is the conventional—and always satisfactory—finish for iron.—KENDALL FORD.

AFTER-DINNER SERVER FOR CIGARETTES

A CIGARETTE server of distinctive design with four separate ash trays may be easily made from 18-gage soft sheet copper. All the pieces are hammered on one side before being bent. The trays are hammered flat, and are bent to shape over a wooden block, which is held in the vise as shown.

Rivet the parts together with No. 14 brass escutcheon pins. The pieces are colored after they have been assembled. Dissolve a small bit of liver of sulphur in about a quart of water; then, after washing the trays and holder thoroughly in soap and water, immerse them in the solution until they turn brown. Finally wash, dry, polish, and lacquer them. Use a clear brushing lacquer or a lacquer sold for protecting polished metal from tarnishing. —DICK HUTCHINSON.



Sketches of parts for the cigarette server

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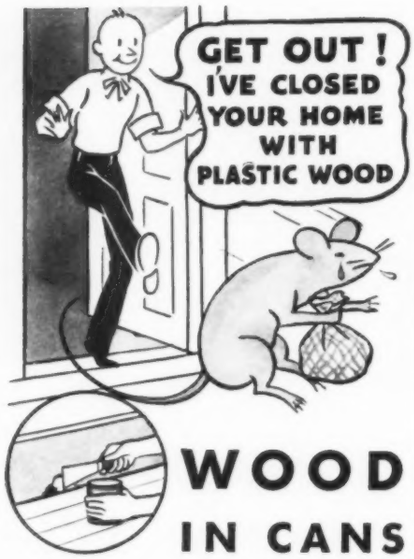

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LOG-CABIN *Bird Houses*

Easily Built from Scrap Lumber

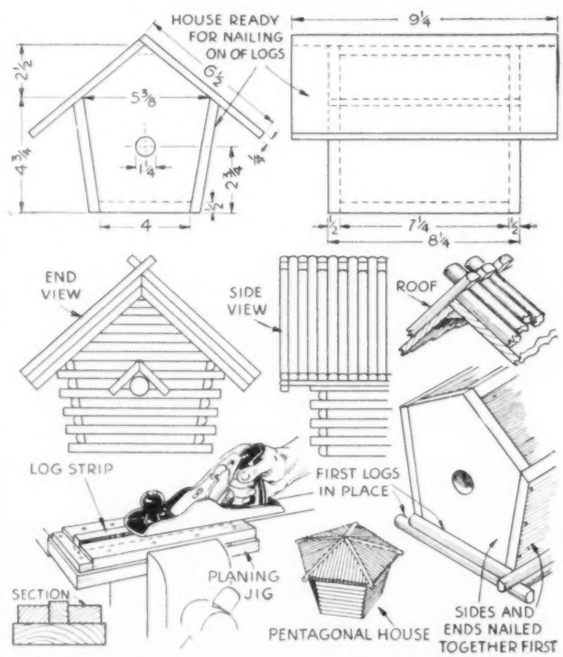
By *Herman Hjorth*

CHILDREN—and grown-ups, too—get much enjoyment and satisfaction from observing birds and listening to their cheerful songs. There is no better way to entice birds to build nests nearby than to provide comfortable boxes or houses for them.

The bird houses illustrated are built very substantially and will keep the small feathered occupants warm and cosy during cold and inclement weather. The design, for which I am indebted to my friend and colleague Mr. H. A. Carlberg, represents a miniature log cabin. It enables many variations to be made in respect to both size and shape.

The first step is to nail together an ordinary bird house consisting of two ends, two sides, bottom, and roof. It is best to use ½-in. stock for this. Any kind of scrap lumber may be used in its construction.

Lay out the parts according to the dimensions given on the drawing. It may be well to bore the entrance hole before sawing out the boards, as a small, thin board splits easily when a large hole is bored in it. Bore the hole slanting a little toward the top of the house to prevent rain water from entering. The size of the hole depends upon the type of bird for which the house is intended. A tabulation of dimensions for various birds will be found on the following page.

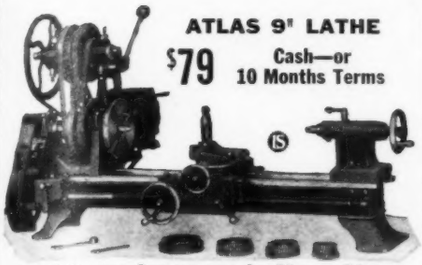


End and side views of a typical bird house; how "logs" are planed and applied; and a suggestion for a five-sided house

Now saw the boards well outside the lines marked. Nail the two ends and the two sides together and plane them to the lines so that they will be of exactly the same size. Plane the bottom carefully, because it should fit tightly between sides and ends. Bore a couple of ⅛-in. holes in the bottom for drainage.

Nail the bottom and the two ends together. Cut a stick to the same length as the bottom and nail it between the ends at the ridge of the roof to make this point firm. Plane off any projecting parts of the bottom and the stick flush with the ends, and then nail the sides in place.

The "logs" are sawed from a 1/16- or 3/8-in. board. Plane the edge of the board and gage its thickness parallel to the edge. Rip off one "log" and plane the rough, sawed edge in a planing jig made



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List of Materials

No. of Pieces	Description	T.	W.	L.
2	Ends	½	6¾	5⅜
2	Sides	½	4¾	8¼
1	Bottom	½	4	7¼
2	Roof	¼	6½	9¼
2	For wall logs	½	9	17
2	For roof logs	½	12	16

NOTE: All dimensions are given in inches.

as shown in the drawing. Plane the edge of the board again and repeat the operations until enough logs have been made.

Nail the logs to the sides and ends as shown in one of the sketches. The ends should be covered right up to the ridge before the two ¼-in. roof boards are nailed in place. These are also covered with logs as shown.

It is perhaps better not to provide a perch below the hole, because sparrows will alight on it and annoy the occupants of the house, sometimes even driving them away. The song birds do not need the perch anyway, because they are able to fly directly to the hole.

The house should be stained or painted a rather dark, subdued color. Bright vivid colors and shiny surfaces do not appeal to the birds. If paint is used, it should be flat drying. If stain is preferred, the house may be given a coat or two of linseed oil to help preserve the wood. Woods best suited for outdoor work are cypress, cedar, redwood, and white pine.

This is the seventh of a series of simple woodworking articles by Mr. Hjorth. Suggestions for the subjects of future articles will be welcomed from readers.

HOW TO DESIGN A HOUSE TO SUIT ANY BIRD

MANY questions asked by readers about the construction of bird houses can be answered by reference to the following tabulation. It originally appeared in a somewhat different form in an article "Houses the Birds Really Like," by F. E. Tustison and A. G. Brown (P. S. M., April '26, p. 78).

Birds	Floor of cavity	Depth of cavity	Entrance above floor	Diameter of entrance
Bluebirds	5 x 5	8	6	1½
Robin	6 x 8	8	*	*
Chickadees	4 x 4	8-10	6- 8	1⅛
Titmouse	4 x 4	8-10	6- 8	1¼
Nuthatches	4 x 4	8-10	6- 8	1¼
House wren	4 x 4	6- 8	1- 6	⅞
Bewick wren	4 x 4	6- 8	1- 6	1
Carolina wren	4 x 4	6- 8	1- 6	1⅛
Violet-green swallow	5 x 5	6	1- 5	1½
Tree swallow	5 x 5	6	1- 5	1½
Barn swallow	6 x 6	6	*	*
Purple martin	6 x 6	6	1	2½
Song-sparrow	6 x 6	6	**	**
House-finch	6 x 6	6	4	2
Starling	6 x 6	16-18	14-16	2
Phoebe	6 x 6	6	*	*
Crested flycatcher	6 x 6	8-10	6- 8	2
Flicker	7 x 7	16-18	14-18	2½
Golden-fronted woodpecker	6 x 6	12-15	9-12	2
Red-headed woodpecker	6 x 6	12-15	9-12	2
Downy woodpecker	4 x 4	8-10	6- 8	1¼
Hairy woodpecker	6 x 6	12-15	9-12	1½
Screech owl	8 x 8	12-15	9-12	3
Saw-whet owl	6 x 6	10-12	8-10	2½
Barn owl	10 x 18	15-18	4	6
Sparrow-hawk	8 x 8	12-15	9-12	3
Wood-duck	10 x 18	10-15	3	6

*One or more sides open. **All sides open.

NOTE: All dimensions are given in inches.

"YOU SAID A PIPEFUL," OAK PARK MAN WRITES

The enthusiastic pipe smoker tries and tries and tries to find the pipe tobacco of his ideal. He is always searching for that one tobacco which will fit his taste exactly. Some seem good for a while—but "they don't last."

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VIC OLSEN

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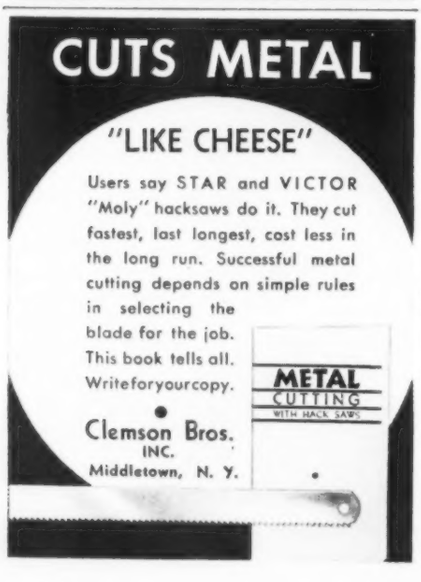
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Miniature IGLOO CONCEALS PASTE POT

THIS desk ornament—a model of an Eskimo's snow igloo on an ice cake—houses a paste pot, while the paddle on the kayak serves as a letter opener.

The base of the miniature is a piece of ¼-in. plywood with an elliptical front edge. Bore a shallow depression to fit the paste jar. Sanded and painted medium blue, this baseboard represents the ocean.

The ice cake and iceberg are of ¼-in. three-ply, sketched and sawed to shape, and nailed together with the lower edge of the berg resting on top of the cake. As this assembly is hinged to the back of the base, it is well to set in the hinges on the lower side of the cake before nailing the two parts together. Also cut a hole 4 in. in diameter, over which to mount the igloo.

Turn the snow house from a block of wood. Mount the blank on a faceplate and shape a semispherical hollow in it. Remove, mount another block, and turn it convex to fit into the hollow. Press the igloo block over it, put a screw through the top, and turn the outside.

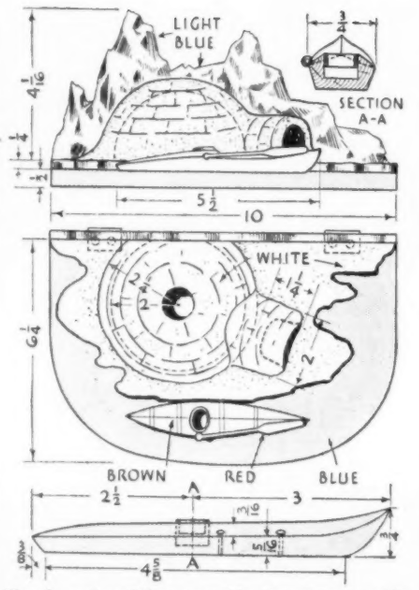
The top of the kayak can be roughed out quickly with the aid of a bandsaw sanding belt if one is available

Carve the entrance piece, fitting it against the main section of the shelter. Saw out a smoke hole in the roof, slice off the rear side to butt against the iceberg, and assemble the parts on the ice cake. Then, to remove the machinelike regularity of the turning, work over the igloo with a plastic wood composition or gesso, scratching in suggestions of joints between the snow blocks. Model snow mounds on the ice, rounding them up into the house, as indicated in the photograph at the beginning of the article.

Carve the kayak from a pine blank ¾ by ¾ by 5½ in. Curve the top and trace on it a pattern for the sides. These are sawed with considerable underslope, after which the cockpit is bored. The top, gable fashion, slopes from a center ridge to the sides. Drive two brads near one edge to hold the paddle, and nail the boat to the base.

The paddle may be carved from wood or ground from a piece of hack-saw blade, with the handle like an arrowhead, sharpened for opening letters. The paddle end is the handgrip.

Paint the iceberg light blue with patches of light and dark lavender. The ice cake and igloo are white, the kayak is raw sienna with brown straps across the top, and the paddle is red.—EDWIN M. LOVE.



Kayak and paddle, assembly drawings, a side view of the kayak, and section A-A through it

LACQUER BRUSHES KEPT CLEAN WITH ACETONE

A CLEANER for lacquer brushes that may be used in an emergency as a satisfactory and inexpensive substitute for the regulation lacquer thinner is acetone, a colorless liquid that can be obtained at drug stores. On relatively unimportant work it can also be used as a thinner for cellulose lacquers provided one part of amyl acetate is added to every five parts of acetone. Brush marks on lacquered work can be removed by spraying with acetone. I have also found that acetone makes an excellent quick-drying thinner for ordinary shellac.—O. B.

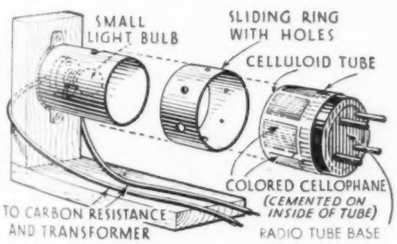
Simple Microscope Lamp Gives Wide Range of Light

By H. J. Sexton

AN EFFECTIVE microscope lamp, which has an adjustment for various light intensities and a choice of numerous light apertures and several color filters, can be built from the base of a burned-out radio tube, a metal socket for the tube, an adjustable carbon resistance, a 10-volt bell-ringing transformer, a 6.3-volt radio panel-lighting bulb, a screw base for this lamp, a piece of transparent celluloid, small strips of variously colored cellophane, a piece of 1/16-in. strip brass, a 9-in. piece of ¼ by 2 in. hardwood or bakelite, some insulated electric wire, and a socket plug. About half a dozen small brass bolts and nuts such as are used for radio work are also required.

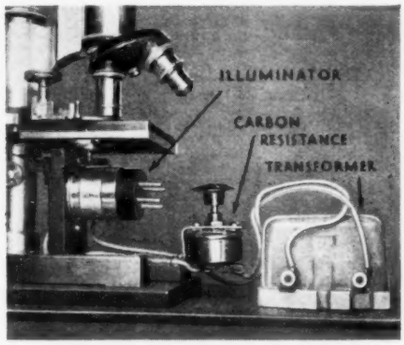
The piece of hardwood is cut into two parts. These are fastened together with three screws at right angles to form a support for the lamp. The support, when assembled, must be of such dimensions that it will just fit under the microscope stage. To the upright part is affixed the radio-tube socket, the screw base for the small lighting bulb, and the necessary insulated wiring for the lighting circuit. The adjustable carbon resistance is fastened to the base by means of a brass strip, and connected in series in the lighting circuit. From the strip of 1/16-in. brass is formed a ring to fit the metal radio-tube socket on the outside. This ring is drilled in a line around its periphery with various holes from 1/64 in. or smaller to 1/32 in. or larger in diameter. The socket itself is drilled at its highest point, immediately underneath the opening in the microscope stage, with a ⅛-in. drill. The ring is now placed over the socket. By turning it, various-sized openings for the light can be brought in line with the ⅛-in. hole.

The color filter, which revolves inside the radio-tube socket and around the small light


SMALL LIGHT BULB
SLIDING RING WITH HOLES
CELLULOID TUBE
COLORED CELLOPHANE (CEMENTED ON INSIDE OF TUBE)
TO CARBON RESISTANCE AND TRANSFORMER
RADIO TUBE BASE

The parts separated to show how the size of aperture and color of light are controlled

bulb, is made from the base of a radio tube, a piece of transparent celluloid, and several variously colored strips of cellophane. The glass of the radio tube is broken, and the bulb base sawn off about ⅜ in. from the prong end. A cylinder is made of the transparent celluloid and cemented to the sawn-off tube base. Narrow strips of the colored cellophane are cemented with Canada balsam lengthwise inside this transparent celluloid cylinder. One section, however, is left uncovered to provide a white light. The cylindrical color filter, when assembled, must fit inside the metal radio socket. The projecting prongs form a handle for revolving the cylinder, bringing each of the color filters in succession between the light bulb and the opening in the outside ring. The lighting wires are now connected to the 10-volt side of the bell-ringing transformer, and the 110-



This microscope lamp is easily adjusted for light intensity, color, and size of aperture

volt side of the transformer is connected to the house lighting circuit by means of a socket plug.

Adjustment of the light intensity is obtained by operating the carbon rheostat. Adjustment of the light aperture (or iris) is obtained by revolving the brass ring on the metal radio-tube socket, and either a colored light or white light is obtained by revolving the cylindrical color-filter holder inside the socket.

It will be observed that the voltage on the output side of the bell-ringing transformer, 10 volts, is greater than the small incandescent bulb capacity, 6.3 volts. This is necessary to bring the bulb to full brilliance, but the circuit is always used with some resistance in. A flashlight bulb of from 2.5 to 4.5 volts may be used when connected to a dry or storage battery, and satisfactory results obtained.

The instrument, when scientifically constructed, furnishes a method for standardizing light intensity under the control of a calibrated rheostat. Light aperture and color density from standardized filters are determinable factors that enable various observers to obtain similar light conditions.

METAL DECORATED WITH FUSED GROUND GLASS

By fusing particles of colored glass on small metal parts, they can be given a permanent, hard finish resembling millions of tiny jewels. The best glass for the purpose is annealed tubing such as that used for chemical experiments and making neon signs. Grind a few pieces of the different colored glass in a mortar until it is almost pulverized; it may then be sifted through wire gauze to remove any coarse particles.

The article to be finished should be sufficiently heavy so that it will not bend easily. It must be well cleaned of grease and foreign matter and then coated with a thin film of ordinary water glass (sodium silicate solution). The powdered glass is immediately sifted over it thoroughly and allowed to dry.

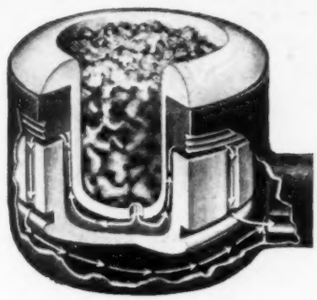
For the fusing process use a bunsen burner. The larger it is, the better. Hold the prepared object directly in the flame by means of pliers or tongs and keep it moving until all of the glass has partially fused together and the tiny, sharp pieces appear smooth and rounded. Remove from the heat very gradually to allow the metal and glass coating to cool at the same rate of speed, otherwise the glass will chip.

The process has many variations and applications. It may be applied not only to metal, but also to glass vases, test tubes, tubing, and other surfaces that will withstand heat. Designs in colored glass may be formed by painting them on the object with water glass and covering with the desired color of powdered glass. The treatment is repeated with different colors, and all are fused at one time.—K. M.

Look into the new

Imported British

BUTTNER



—and SEE for Yourself Why It Smokes So Dry, —So COOL and Sweet!

SEE that hollow fluted filter of absorbent ceramic around the BUTTNER'S inner bowl? Follow the little arrows and see how the smoke travels: Out of the bowl's bottom. Up the filter's inside surface—over the edge—and down its outside surface to the stem, and your mouth.

Here's the Clever Little Filter That Cools and Dries the Smoke

The smoke is drawn across more than 7 square inches of this ceramic filter's absorbent, cooling surface. No wonder it arrives at your lips cool, dry and sweet, with all the heat, moisture and unhealthy toxins absorbed by the porous filter. Nothing to irritate or harm tongue, throat or lungs can enter your mouth.

When the filter gets brown from absorption, put it in a gas-stove flame a minute. It comes out snow-white and ready for use again.

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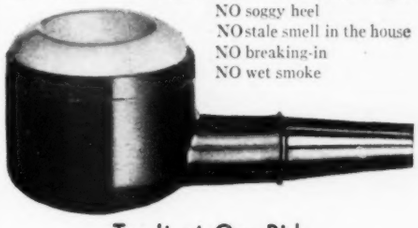

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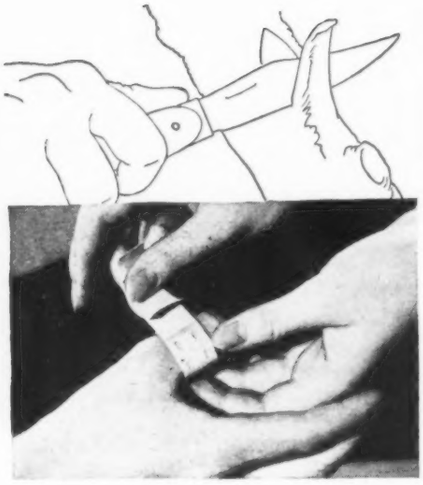

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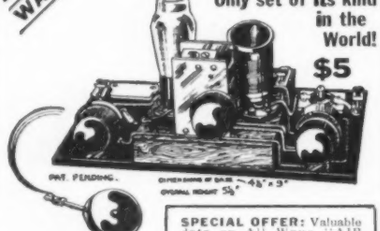

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No Time Wasted When You Use Our

Construction Kits

"I NOTE that you list a number of blueprints for ship models. Making a ship model is a hobby that would appeal to me, but I do not know which one to try first. What do you recommend?"

This is one of innumerable similar questions asked by readers. By far the best way to get started in ship model making is to buy one of our construction kits. These contain all the necessary raw materials as well as the full-size blueprints. There is a great advantage in this because it is an exasperating and discouraging job for a beginner to find suitable materials for making a model. A number of different items enter into the construction of even a simple model, and some of them are difficult to obtain, especially in small quantities.

The easiest of our models to make are the *Manhattan*, the *Indianapolis*, and the *Sea Witch*. These are very small and require few tools beyond a pocketknife, a few single-edged razor blades, and a pair of pliers. Even boys of thirteen and fourteen can make the first two without difficulty.

From one of these simple models, the beginner can advance to the Spanish galleon, the *Revenge*, or the battleship *Texas*. Finally, for the ship model maker who wishes to build a model that will be worth several hundred dollars when finished, either the whaling ship *Wanderer* or the sloop-of-war *Hartford* may be chosen.

Those who wish to take up furniture construction will also find there is no better way than to begin with our furniture construction kits.

All kits are accompanied by instructions or blueprints. The list continues on the following page.

A. Whaling Ship model *Wanderer*. All the raw materials together with Blueprints Nos. 151 to 154 and booklet. The hull is 20½ in. long.....$6.90

AA. Same with hull lifts sawed .. 7.40

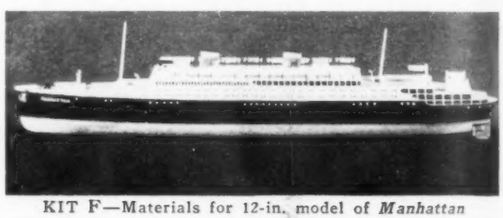
D. Spanish galleon ship model, 24 in. long. All the raw materials (except paints), Blueprints Nos. 46 and 47, and a booklet 6.45

DD. Same with hull blocks shaped.. 6.95

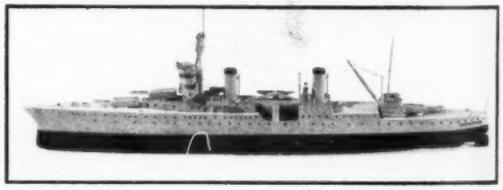
E. Battleship model, U.S.S. *Texas*, 3 ft. long. All the raw materials (except paints) and Blueprints Nos. 197 to 200..... 6.95

EE. Same with hull lifts sawed.... 7.45

NO. 6

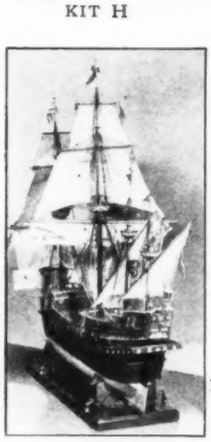


KIT F—Materials for 12-in. model of *Manhattan*

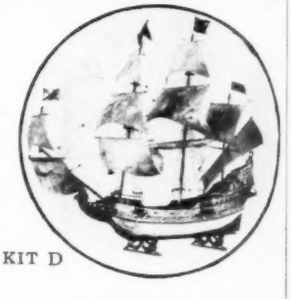


KIT H

The historic *Hartford*—KIT L

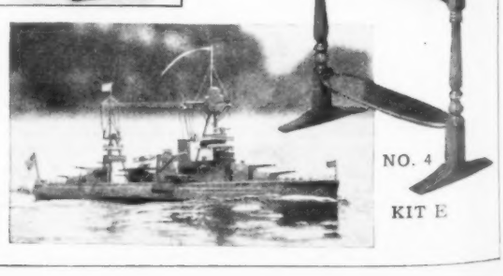


KIT G



KIT D

NO. 5



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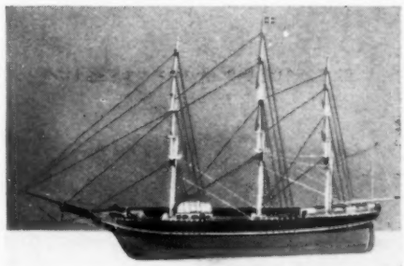

KIT J

Materials for a miniature clipper ship

NO. 2

KIT A

F. Liner *Manhattan*. All raw materials (except paints) for a simplified miniature model 12 in. long, and Blueprint No. 204. 1.00

G. Elizabethan galleon *Revenge*. All raw materials (except paints) for a model 25 in. long, and Blueprints Nos. 206 to 209.. 6.75

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H. Cruiser U.S.S. *Indianapolis*. All raw materials (with enamels) for a simplified 12-in. model, and Blueprint No. 216.. 1.50

J. Clipper ship *Sea Witch*. All raw materials (except paints) for a simplified 13-in. model, with blueprint..... 1.50

L. Farragut's flagship *Hartford*, a steam-and-sail sloop-of-war. All raw materials (except paints) and special Blueprints Nos. 221 and 222. The hull is 33½ in. long, and the over-all length is 41 in. 7.95

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BOTH subjects are exclusive designs by a prominent artist craftsman. They are entirely new and fashionable, and any one of reasonable skill can make them with few tools. The Bracelet can be made of sterling silver or nickel silver (German Silver), either by saw piercing the design or by etching it. Directions for both operations are given. The Bowl, including its legs, is hand hammered from a single piece of sheet copper (no soldering). The Bulletin gives directions for tools required, some of which most home craftsmen already own.

—o—

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The quick and easy road to ship modeling is to get one of our accurate scale construction sets. With them you can concentrate on the interesting part of the model. Similar sets for models of Flying Cloud, Destroyer Preston, Constitution, U. S. S. Texas, Whaler Wanderer and many others. Also semi-finished hulls and all sorts of materials and fittings such as blocks, deadeyes, anchors, steering wheels, guns, lifeboats, etc. Large 64-page photographically illustrated booklet, describing the above sent postpaid upon receipt of 15c (coin). Many persons on receiving this booklet, have discovered how simple and enjoyable is ship model making. Be sure to get your booklet before starting your model.
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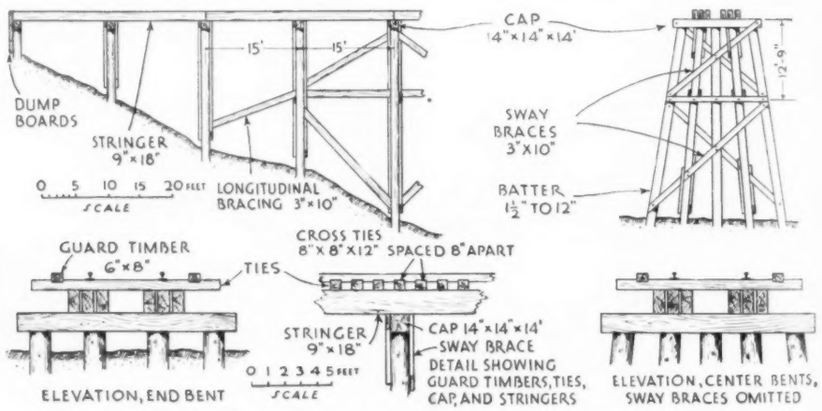
BUILDING TRESTLE FOR MODEL RAILWAY

EVERY miniature railroad needs at least one bridge on the system. As our road is in the pioneer stage of construction, the old-fashioned pile trestle will probably be the best type to start with. True, these structures are obsolete on an up-to-date main line, but they make a model more picturesque and will be entirely appropriate on a branch line or "mountain division."

Dowel sticks are the most popular material for the piling, but a more realistic effect may be obtained if small, straight willow branches are used. The branches should be peeled and thoroughly dried. And don't forget that the small end of the pile goes down. Sway braces and longitudinal bracing may be made of wood or cardboard. Note that the sketch shows two sets of three 9 by 18 in. stringers at each side of the trestle. It probably will be more convenient in making a small-scale model to substitute one solid strip for each set.

The length of the trestle has not been shown on the drawing for the reason that as many 15-ft. spans may be used as desired. The dimensions given are all full size, and a scale in feet has been provided so that a model can easily be built to any desired scale, depending upon the track gage of the railway. The dump boards at the end of the trestle are usually secondhand timbers of any size, provided, of course, they are sufficiently long to hold the embankment away from the end bents.

The whole structure should be finished with a silver gray stain to give it a weathered look.—J. W. CLEMENT.

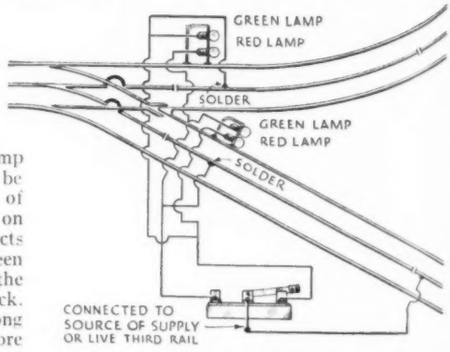


These drawings show the construction of an actual trestle such as the one in the photo, and the full-size dimensions are indicated. From these a model can be built to scale

A SAFE WAY TO WIRE MODEL SWITCHES

ON MY model railway system a number of accidents occurred at one of the switches, and finally a car was ruined. I then installed the wiring shown in the accompanying diagram. This is an economical method of preventing accidents and adds realism to the track layout.

One wire is connected to the green lamp on the first track, which, of course, must be insulated or isolated, and to the third rail of the same section, and also to the red lamp on the second track. A second wire connects the red lamp on the first track and the green lamp on the second track, and runs to the isolated third-rail section of the second track. Be sure that the isolated sections are long enough to let the train roll to a stop before it reaches the end of the section. For my panel board I use a single-pole, double-throw switch.—LEONARD BLAND.



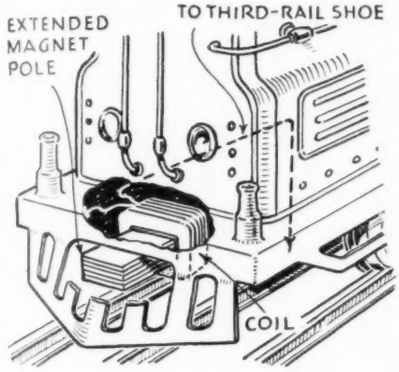
Although the wiring of this model railway switch looks complicated, it is quite easy to install and makes accidents impossible

RUBBER BANDS REPLACE SCREEN-DOOR SPRING

A GOOD substitute for a long coiled screen-door spring can be made from several large rubber bands cut from heavy tire inner tube, looped together end to end. The rubber bands should be at least ½ or ¾ in. wide. One end, of course, is secured to the screw eye or hook in the door, and the other to the door casing. This arrangement is absolutely quiet in action, and the rubber does not damage the door.—R. R. RUNDELL.

MAGNETIC COUPLER FOR MODEL SWITCH ENGINE

A MODEL switch engine built by the writer has, as a novel feature, magnetic couplers which operate automatically. Such couplers will not, of course, handle heavy trains, but switching operations may be carried on in a realistic manner with single cars, or with two cars coupled together. The system is best adapted to electric-type locomotives having remotely controlled reverse. The



Model locomotive with a magnetic coupler that works automatically for switching cars

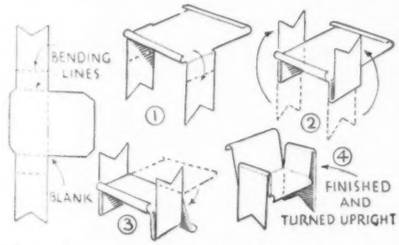
regular coupler may be retained at the rear end, and the magnetic device installed in front.

Sufficient space must be available to mount a small electromagnet between the motor chassis and the pilot, with the pole piece projecting through the upper part of the pilot. If the latter is of sheet metal, the required opening can be cut without difficulty. The magnet may consist of about 300 turns of No. 28 enameled wire wound on a laminated core of tin or transformer iron. For an "O" gage locomotive, a suitable cross section for the magnet core is ⅜ by ⅜ in. One end of the winding is grounded to the frame, the other connected to the third-rail roller.

The coupling is accomplished when the pole piece makes contact with the coupler of a car. It can be released by cutting off the power while the engine is pushing the car, so that the latter coasts out of range of the magnet.—CHARLES D. SAVAGE.

MODEL PULLMAN SEATS MADE IN ONE PIECE

THE model railroad builder who constructs his own Pullman coaches finds it a big job to make the seats. The sketches below show how I cut and bend the seats from sheet metal. Each set is made from one piece and painted neatly. The sharp points at the bottom are driven slightly into the



A simple method of cutting and bending miniature seats for use in a model Pullman car

floor and hold the seat firmly. It is best to make a pattern very carefully from thin tin so that it can be laid down and marked around. I cut the metal in 3½-in. strips, which is correct for seats for standard gage cars. For "O" gage Pullmans, the stock would be smaller.—BOYD J. MCWHORTER.

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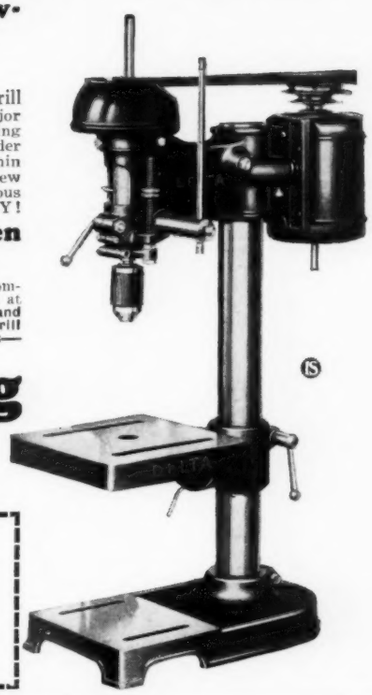

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78" Rule open Bakelite Case—Automatic Push $2.75 doz.
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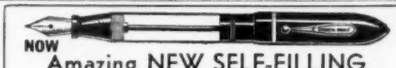

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Amazing NEW SELF-FILLING FOUNTAIN PEN only $1.50

A new sacless vacuum self-filling pen at a new low price. No increase in size of pen . . . but three times more ink in same size barrel. Ink is visible through non-breakable transparent reservoir. Guaranteed 14 kt. solid gold pen with hard iridium tips. Order yours today at this special price of $1.50 postpaid. C.O.D. orders filled.

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Runs on 110 A. C. or D. C. current. Variable speed and reversible up to 6,000 R. P. M. This motor is made from a Model T generator which can be bought for 50c at any auto wrecking Co. You use the same field coil — the only change is in the armature and brushes. Send for this plan and instructions; so simple any boy can understand. $2.00 brings you complete plan. No additional cost. Address

¼ H. P. $2.50

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The Midget *"Five-in-One"* Slide Rule is a combination Mannheim, Polymetric, Log-Log, Binary, Add and Subtract Slide Rule. It will instantly add, subtract, multiply and divide any combination of whole numbers, fractions, mixed numbers and decimals. Gives every root and power, also Logs, Sines and Tangents. Made of aluminum with scales on white celluloid. Size 4 in. Approved and adopted by colleges. Price with instructions, $1.50. Fabricoid Case 50c extra. Sent C.O.D. if desired. Catalogue Free. **GILSON SLIDE RULE CO., Stuart, Florida**

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. . . . . either Cross-cut or Rip, or Combination—to fit your bench saw . . . . .

Here's an amazing value in circular saws for homecrafters, and others who have small bench saws—circular saws made by Disston at prices you will be glad to pay. See them at your dealer's; if he does not have them, write giving his name and we will see that you are supplied.

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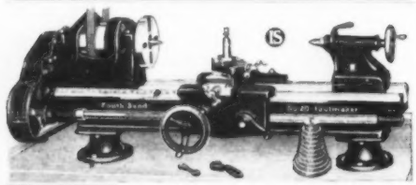
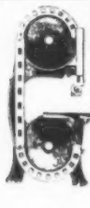


$128 as shown

The 9" South Bend "Toolmaker" is a back-geared screw cutting lathe. Has ¾" hole in spindle; six spindle speeds; graduated compound rest; set-over tailstock for taper turning. Bed lengths 2' to 4'. 3' size weighs 325 lbs. Write for new Catalog No. 39 showing 18 other models of 9" Lathes as low as $108. Sent free, postpaid, on request.

South Bend Lathe Works
345 E. Madison St., South Bend, Ind.



COMBINATION JIG AND BAND SAW $9.45

All features, 9" wheels, 4" depth, table insert, rigid construction, positive alignment, 10" x 10" tilting table. Price of saw $9.45, set of aluminum guards, $1.50, jig-saw attachment $3. Blade 60" $1. Shipping weight 42 lbs. Send postcard for catalog of complete power tool line at these amazingly low prices, and details of trial offer and satisfaction guarantee, or save time and send $1. Balance C. O. D. plus express. 6" swing wood-turning lathe, $4.50. 6" metal working lathe, $7.50 complete with slide-rest and chucking device; 6" bench saw, $4.75. **American Machine & Tool Co., 200 Broadway, Dept. P. B. New York**

THE NATIONAL HOMEWORKSHOP GUILD

(Continued from page 69)

both amateur and professional mechanics, this method of furthering the movement should be helpful both to those who wish to organize a club and to those who cannot spare the time to do that but would like to join a club when one is formed in their neighborhood. Pay a visit to your hardware dealer and talk it over with him. He will be able to tell you if a club is being formed in your locality and will have other information of importance.

"Hardware Age," leading magazine in the hardware trade, has actively helped to arrange for the coöperation of hardware dealers and has published a comprehensive article about the purposes and advantages of the Guild. Through "Hardware Age" and the hardware dealers, it is hoped to reach many amateur craftsmen who otherwise might not know about the formation of the Guild.

One of the new clubs, the Peekskill Homeworkshop Club, of Peekskill, N. Y., mustered nineteen charter members at its first meeting, and the Arts and Crafts Club at Menomonie, Wisc., reported that fifteen charter members attended its organization meeting.

Other clubs previously formed also notified national headquarters of the addition of new members. Except for the original club at Rockford, the Topeka Homeworkshop Club, of Topeka, Kans., now has the largest membership with thirty-one on its roll, but several clubs are creeping up on it.

The Topeka Club played Santa Claus at the Shawnee County Parental Home and distributed fifty toy airplanes, doll beds, wagons, and other wheeled toys. This club meets at the Chamber of Commerce in Topeka and has had informative demonstrations on craftwork by Fred Jepson and A. W. Larson, industrial arts instructors in the Topeka public schools. The members have already made tentative plans for starting the production of toys for next Christmas so that members can work on the projects whenever they have any spare time through the year.

The Amarillo Homeworkshop Club, of Amarillo, Texas, coöperated with the local fire department, which annually collects and repairs old toys for Christmas distribution. Club members made about 100 new toys to be added to the ones repaired by the firemen. Wives of the members prepared the mattresses for the doll cribs, the material being supplied by a mattress factory. Some of the small mattress covers were decorated with a beautiful design, the work being done by a printer who belongs to the club. Wives of the members also dressed twenty-five dolls which are not shown in the photograph on page 69. The lumber used for most of the toys was taken from apple boxes. The guns shown at the top of the photograph shoot rubber bands made from old inner tubes. To make so many toys in such a short time was a remarkable demonstration of industry and enthusiasm on the part of the club members.

The Morristown Homeworkshop Club, of Morristown, N. J., held its first meeting in the home of K. C. Bates, the secretary, and its next meeting in the local high school. Harold Eaton, an instructor of craftwork at the high school, is one of the members of the club. This club was one of the first to prepare printed stationery of its own.

The Guild, in its various bulletins, has not offered suggestions for the stationery of local clubs, but it is obviously a great advantage for a club to have a neat letterhead for all official correspondence. The Guild is having line cuts (engravings) made of the official seal as it appears on its own stationery. These can be obtained by the local clubs at cost from national headquarters. The use of the seal with plain, neat type and a good quality of paper will make a club letterhead of excellent appearance.

E. Raymond DeLong, secretary of the Guild, has answered a number of new questions. One that is asked repeatedly is: Does the guild recognize all branches of homecraft work? The answer, of course, is yes. He has stressed the fact that diversified hobbies in a club are to be desired as they stimulate interest, are educational, and appeal to the true homecrafter, who is usually eager to acquire a knowledge of craftwork other than his own particular hobby. Many a man has tried only one or two specialties in the home workshop field, and until he knows more about the hundred and one other branches he cannot be sure that he has chosen the particular type of work which will give him the most enjoyment.

WHAT IS *Your* Club DOING?

SECRETARIES of local home workshop clubs should report all interesting activities to Guild headquarters. Send in notices of special programs, demonstrations, and addresses. If the mayor of your town, a leading surgeon, or some other prominent man joins your club, that is news worth publishing. Mail all such notes promptly to E. Raymond DeLong, secretary of the National Homeworkshop Guild, 312 Harper Avenue, Rockford, Ill. Extracts from these reports will be published every month in the Guild columns of POPULAR SCIENCE MONTHLY.

Some requests are made for recommendations as to the best brands of tools and equipment to be purchased. As the Guild is entirely noncommercial, it can make no special recommendations. Its attitude in regard to manufactured products obviously must be one of complete impartiality.

It should be repeated that clubs may be formed in Canada for affiliation with the Guild.

Since the March issue went to press, the following clubs have been organized:

Antioch Homeworkshop Club, Antioch, Calif.—R. H. Cameron, president; Mott Pridgen, secretary; B. L. Jackson, treasurer.

Arts and Crafts Club, Menomonie, Wisc.—Harry A. Beach, president; Norman A. Jensen, secretary; Hartvick J. Dotseth, treasurer.

Billings Homeworkshop Club, Billings, Mont.—Thomas A. Purcell, president; Ellis Marshall, secretary; Cecil Farris, treasurer.

Bristol Homeworkshop Club, Bristol, Conn.—John Wilson, president; Reginald C. Morrell, secretary; Dr. J. S. Wilson, treasurer.

Cheyenne Hobby Club, Cheyenne, Wyo.—William F. Winkle, president; Edward L. Kopp, Jr., secretary-treasurer.

Craftsman's Homeworkshop Club, St. Louis, Okla.—E. W. Pearce, chairman; John H. Gilmore, vice chairman; Bruce McClaflin, secretary-treasurer.

Eastchester Homeworkshop Club, New York, N. Y.—John LaRusso, president; Anthony Nicosia, *(Continued on page 101)*

HAENEL "100 SHOT" REPEATER

$4.95

Latest Model 1934 Haenel repeating pistol. Sturdy, massive construction, easy cocking lever, 100 shot magazine. For target. Powerful for small game. Blue or Nickel finish, shoots B.B. steel shot. Weight 18 oz. FREE—500 Shots, 10 Targets, Leather Holster. $2.00 deposit on C. O. D. FREE Catalog—Colts, Rifles, Binoculars, etc.

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NOW—A Slide Rule for 50c

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Classy! Roomy! Easy to build at low cost! Accommodates 2 to 4 people. Plans and instructions, only $1.00—include all diagrams, sketches, photos, material list, etc. Big value for all interested in camping trailers of any kind. Rush your order today!

ALL PLANS AND INSTRUCTIONS FOR $1.00

Mail Dollar Bill to JIM DANDY, Box 125-B, Wausau, Wis.

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Locomotives - Railways - Ships - Yachts

Steam locomotive catalogue (Bassett-Lowke, Ltd.). An illustrated, 166 page informative booklet covering steam locomotives, railways, track, and equipment. Price 40 cents.

Electric locomotive catalogue (Leeds Model Co.). A hand book of 120 pages: locomotives, coaches, large radius track, stations and equipment. Price 50 cents.

Ship and yacht list (Bassett-Lowke, Ltd.); 94 pages illustrated. Ships, yachts, fittings, engines, boilers, construction sets. Price 40 cents.

These booklets are handsomely printed on heavy paper.

SILVERMINE ASSOCIATES, NORWALK, CONN.

BIG MONEY Assembling NEW BOAT IN 2 DAYS

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GIVEN! $6 Double-blade paddle now given with your Ki-Yak—if you hurry!

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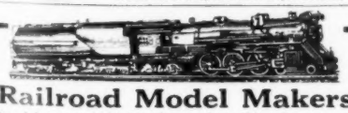

Railroad Model Makers

Send for new 1934 Catalogue describing latest and complete line of Model Railroad Equipment, including duplicates of World's Fair Models. Send 10c for your copy. American Model Railroad Co. Box S, New Rochelle, N. Y.

Always mention POPULAR SCIENCE MONTHLY when answering advertisements in this magazine.

HOMEWORKSHOP GUILD

(Continued from page 100)

secretary-treasurer; Philip Schmitt, librarian.

Elizabeth Homeworkshop Guild, Elizabeth, N. J.—William A. Molyneux, president; Walter I. Howland, secretary-treasurer.

Fairmont Homecraft Club, Fairmont, W. Va.—George L. Davis, president; Archie D. Koon, vice president; Walter Swisher, secretary-treasurer.

Fargo Homecraft Guild, Fargo, N. D.—A. L. Dewey, president; B. N. McCaul, vice president; John C. Pollock, secretary-treasurer.

Goodyear Homecraft Club, Akron, Ohio—L. N. Flatten, president; H. T. Richert, secretary; A. B. Robinson, treasurer.

Ithaca Homeworkshop Club, Ithaca, N. Y.—R. J. Hutchinson, president; E. J. Woodams, vice president; W. H. Elwood, secretary; Harvey Seaburg, treasurer.

Jacksonville Homeworkshop Club, Jacksonville, Fla.—A. B. Russell, president; A. P. Meredith, secretary; R. A. Yockey, treasurer.

Jersey City Homeworkshop Club, Jersey City, N. J.—Robert F. Davison, president; William T. Davin, secretary; William H. Siddons, Jr., treasurer.

Lansdale Homeworkshop Club, Lansdale, Pa.—Charles Weitz, president; Lester L. Fisher, secretary-treasurer.

McKeesport Homeworkshop Club, McKeesport, Pa.—Emil M. Shidel, president; Richard Bevan, secretary; Paul Heptig, treasurer.

Madison Homeworkshop Club, Madison, Wisc.—John S. Moore, president; Charles A. Achtenberg, secretary-treasurer.

Norwood Homeworkshop Club, Norwood, Ohio—Larry Weber, secretary.

Peekskill Homeworkshop Club, Peekskill, N. Y.—Edwin McKinley, president; Harry Sinclair, vice president; Louis Hof, secretary; Raymond W. Ogden, treasurer.

Snoqualmie Homeworkshop Club, Snoqualmie, Wash.—William M. Cowell, president; E. J. Roberts, secretary; Lloyd Leake, treasurer.

Spokane Homecrafters, Spokane, Wash.—W. E. Mitchell, president; W. R. Greene, vice president; Robert E. Pence, secretary-treasurer.

Tipanogus Homeworkshop Club, Provo, Utah—Dr. Albert R. Taylor, president; Milton Marshall, vice president; Ramona F. Cottam, secretary-treasurer.

Two Rivers Homeworkshop Club, Two Rivers, Wisc.—Andrew Demcak, president; Roland Bleser, secretary; Laurence Seefeldt, treasurer.

Warren Homeworkshop Club, Warren, Ohio—P. W. Busefink, president; M. H. Post, secretary; John Finta, treasurer.

Requests for information in regard to forming local clubs have now been received from every state in the Union and from Canada, Hawaii, and Porto Rico. If you wish to know more about the Guild, fill out the coupon below and send it in.

National Homeworkshop Guild
c/o Popular Science Monthly
381 Fourth Avenue, New York, N. Y.

I am interested in the home workshop club idea and wish to know what the National Homeworkshop Guild will do for me. Please send me this information in the large self-addressed and stamped envelope I am inclosing.

Name .....

Address .....

City ..... State .....

(Please print very clearly)

20 BIG PRIZES

Don't Miss This Great Chance to WIN a U.S. Golden Flash Bike or other VALUABLE PRIZES

U. S. Golden Flash Bicycle
Pair of U. S. Chain Tread Bicycle Tires
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Four prizes every month will be given to boys and girls who write the most interesting story on "My Adventure on a Bicycle," or the one best illustrating the value of the bicycle, will win each month, in order of merit. First prize-winning story will be printed in Open Road for Boys, with picture of winner.

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Anyone under 18 years of age eligible. Manuscripts must be less than 300 words, written in ink or typewriter, on one side of paper only. Mail story with coupon below or copy of one properly filled out to address thereon.

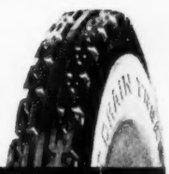
Each story must be a true experience of the writer or some one he knows. Literary ability not necessary, as stories are judged for interest only. Complete details every month printed in Open Road. Last date to mail letters this month, April 30.

Why Experts Choose U. S. Giant Chain Bicycle Tires

Leading manufacturers select U. S. Chain Tread Tires as factory equipment because experts have found them the best.

The following features are built into every tire . . . NON SKID TREAD for safety . . . THREE PLIES of strong fabric for durability . . . FLANNEL RIM STRIP to prevent creeping . . . and PERMANENT WHITE SIDEWALLS with EBONY BLACK TREAD for appearance.

Don't let anyone talk you into using any other tire. Follow the EXPERTS and insist on U. S. Chain Treads. It pays.



United States Rubber Company

U.S. Giant Chains

U. S. RUBBER COMPANY
Bicycle Tire Division
1790 Broadway, New York City

Gentlemen: Attached to this coupon is my true story:

My Name is .....

My Address is ..... St.

City ..... State .....

Name of Nearest U. S. Bicycle Tire Dealer:

Dealer's Name .....

Dealer's Address .....

To the best of my knowledge this story is true.

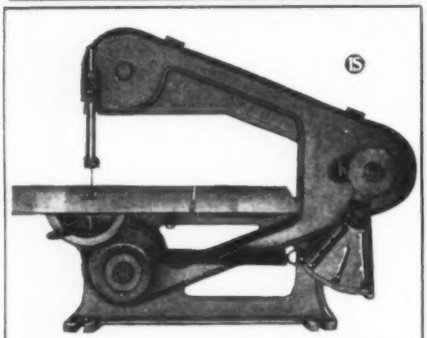
Signed (Parent or Guardian) .....

P.S.

Easy to apply with a brush — completely self smoothing and never leaves ridges or brush marks. The result is as smooth as a mirror. Extremely durable, washable — and waterproof. It dries hard in four hours. Sixteen beautiful colors.

Send for booklet, "Home Color Styles". It's free.

BOSTON VARNISH COMPANY
365 Everett Station, Boston, Mass.



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MASTS AND SPARS FOR THE *HARTFORD*

(Continued from page 71)

boom hangs from the bowsprit cap with an eye-bolt. It is thickest two-thirds of the way down. It has two cleat bands and an eye band at the end. I made the cleats by flattening a piece of wire and working it through the boom, turning each end down at a right angle.

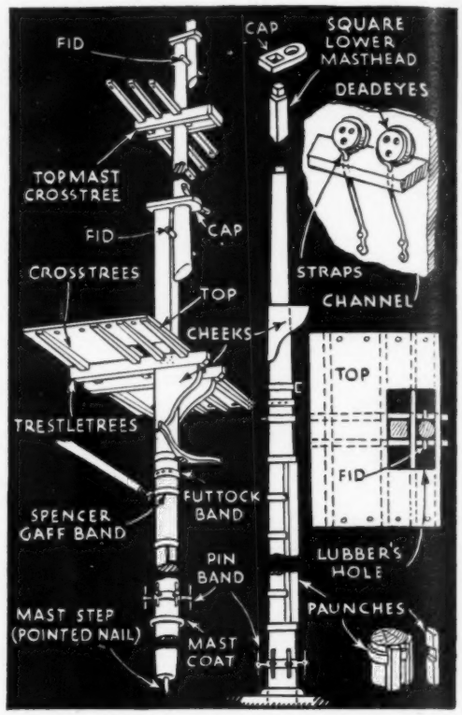
The spritsail yard or spreader for the boom guys is a round spar tapered to both ends, with shoulders for the guys. It is slung under the bowsprit, between the bobstay deadeyes with a wire parrel.

The fore and main spencer gaffs are thickest one third from the mast. I made the goosenecks by binding the ends and driving in bent pins. The spanker gaff is similar but longer. They are the natural wood color with white tips.

The yards are all of the usual shape, parallel in the first quarters and from there tapering to the yardarms where there is a shoulder and then a sharp taper.

The lower yards require trusses. The arms of these I made from No. 18 copper wire, flattened vertically in the middle and horizontally at the ends. The ends are soldered in bands to fit the yard. The middle is drilled for an escutcheon pin, the end of which is drilled to take a pin through the lugs on the mast band. Right amidships there is a band with the sheet sheaves underneath and a bolt for the chain sling above. At the ends are spider bands with three eyes, above, beneath, and abaft.

I fitted all my yards with jackstays. For these I used No. 32 semihard black steel wire. I made the bolts or staples to hold them from the same wire, doubling it sharply over pliers, drilling small holes, and driving them in part way, then reeving the wire through and tapping the staples home.



Sketches showing how the masts are set up with tops, caps, and other fittings; also the deadeyes

I find that footropes (horses) and stirrups made of cord will not keep in position, so made them of No. 32 covered magnet wire. These are fastened to the bolts at the yardarms and to the jackstays. Note that as the yards decrease in size, the arrangement of the footropes varies.

The topsail yards have two-eye eyebolts at the ends, a band and eye in the middle for the halyards, and a saddle and parrel to keep them to the mast. The saddle is cut to shape and bolted to the yard, and the parrel is made from thin brass, drilled to take the pinheads which are used later to bolt it to the saddle. All the yards are painted black.

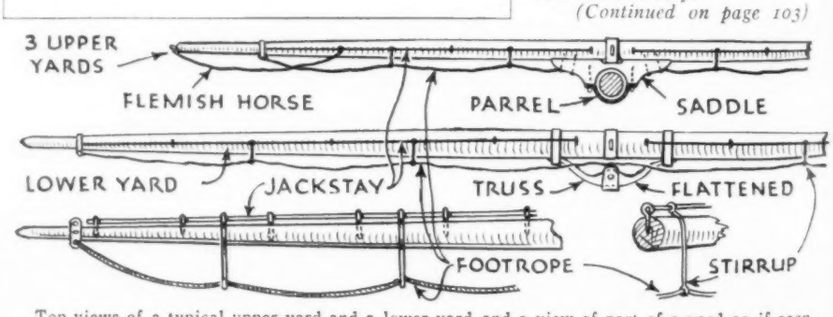
The shrouds and topmast backstays require 3/16-in. deadeyes; the topgallant backstays, 5/32-in.; and the royal ⅛-in. Strap them to the chain plates in any approved fashion.

Fasten also two deadeyes to bolts ⅜ in. forward of the foremast, and put two bolts in the deck just abaft the mainmast for the mizzen stay.

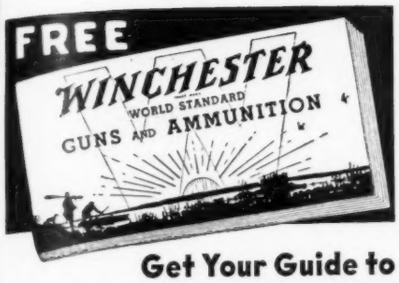
(Continued on page 103)

LENGTH AND GREATEST DIAMETER OF SPARS

	Fore	Main	Mizzen
Lowermasts (from deck)	87/8x5/16	9 1/4x3/8	8 1/8x1/4
Topmast	6 1/2x3/16	7 3/16x3/16	5 3/4x5/32
Topgallant	6 5/8x5/32	7 7/16x5/32	5 1/8x1/8
Bowsprit	6 3/4x5/16		
Jib boom	8 1/2x5/32		
Martingale boom	2x1/8		
Lower yard	11 1/2x7/32	11 3/4x1/4	8 1/2x3/16
Topsail yard	8x5/32	8 1/4x3/16	6 1/4x5/32
Topgallant yard	5 3/8x1/8	5 5/8x5/32	4 1/8x3/32
Royal yard	3 5/8x1/16	3 3/4x3/32	2 3/4x1/16
Spencer gaff	3 1/2x3/32	3 1/2x3/32	
Spanker gaff			5x1/8
Tops	2 7/16x1 7/16	2 9/16x1 7/16	1 7/8x1 1/4
Crosstrees	1 5/8x5/8	1 5/8x5/8	1 7/16x1/2
Square mastheads	1 7/8x1/4	2x5/16	1 1/8x1/4
Total height of masts from deck	19	21	16 1/2
Total length of bowsprit and jib boom from beak	8 1/4		



Top views of a typical upper yard and a lower yard and a view of part of a yard as if seen from directly aft. Note also the sketch showing relation of jackstay, stirrup, and footrope



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MASTS AND SPARS FOR THE *HARTFORD*

(Continued from page 102)

I found it best, wherever a deadeye, block, or line had to be bolted to the deck, to fasten it first to the bolt and then, after drilling a hole, to drive the bolt in.

Before placing the masts, I drove a nail in the end of each so that it would go into the bottom of the hull.

Mast coats should be placed around the masts where they come out of the deck to cover the joint. These are rings about 3/32 in. in section, rounded on the outside and fitting tightly. I made mine of white celluloid, but any solid or plastic material will do.

Fix the masts in position and make the tops to go on them. These consist of fore-and-aft battens called trestletrees into which the crosstrees are half-lapped.

On the crosstrees is placed the floor, which is cut out as shown to take the masts and allow space to pass the rigging through. This is called the "lubber's hole." In the outside edges, the fore and main tops have four slots for the topmast-shroud deadeye straps. At the mizzen only three slots need be cut. Glue and nail the trestletrees above the cheeks, which are firmly bolted to support them.

Next comes the bowsprit. Put this in its hole and pass the gammoning lashing over it and through the holes in the stem. You may need the help of a thin wire to do this. Set up the bobstays from their straps on the stem to the deadeyes under the bowsprit. Chain of from 12 to 14 links an inch is suitable. Also set up the bowsprit shrouds to bolts above and abaft the hawse pipe. Strap two 3/16-in. deadeyes about 3/8 in. apart from under the bowsprit, allowing enough clearance for the jib boom to pass through the straps. These are for the forestay.

TO BE CONCLUDED.

Prizes for Second Photo Contest

IN THE second of our winter series of indoor photo contests (P. S. M., Dec. '33, p. 68), the following prizes have been awarded:

FIRST PRIZE, $25
Augusta Strumpen, Philadelphia, Pa.

SECOND PRIZE, $15
E. P. Fleming, San Diego, Calif.

THIRD PRIZE, $5
John R. Schuck, Findlay, Ohio

FIVE PRIZES, $1 Each
C. W. Smith, Belleville, Ont., Canada; Mrs. Erwin E. Nelson, Ann Arbor, Mich.; Fred M. Fling, Altadena, Calif.; Mrs. Ramon E. Keyser, San Francisco, Calif.; Paul Callicotte, Portland, Ore.

HONORABLE MENTION—*D. W. Cartwright, Menomonie, Wis.; Lloyd J. Cartwright, Saginaw, Mich.; Alice Caton, Knoxville, Tenn.; Yale B. Griffith, Los Angeles, Calif.; Carl T. Julien, Celo, N. C.; Louis C. McNutt, Brooklyn, N. Y.; Mary Wright Pridham, West Palm Beach, Fla.; Adrian M. Savage, Millers Falls, Mass., and Lewis Shirley, Dishman, Wash.*

Winners of the January contest will be announced next month.

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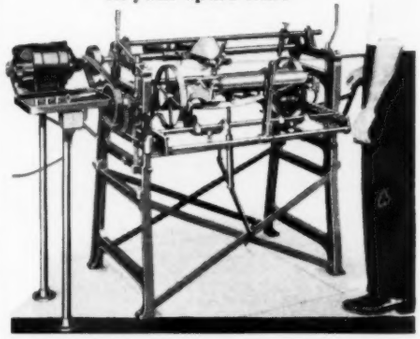

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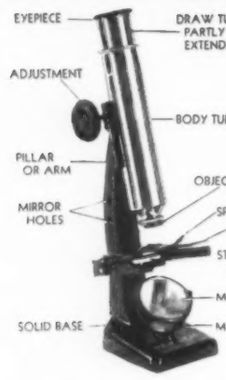

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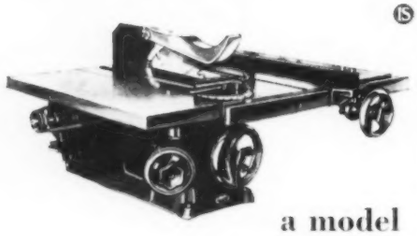

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BE A DETECTIVE WITH YOUR OWN MICROSCOPE

(Continued from page 43)

average amateur microscope usually are used, and the preparation of test smears is an involved process. However, the dairy owner or farmer who wants to control the quality of milk and detect trouble at its source, might profit by a study of the subject.

There are scores of other foods that you can submit to the relentless eye of your microscope. Bread, bits of meat, cereals, tea, and many more will provide countless thrills as their wonders are revealed. In addition, they will be revealing to you their secrets of purity or impurity, and the other qualities that enable you to judge their worth.

THE general method of preparing foods for microscopic examination is to reduce them to small particles and perhaps mix them with water to form a paste. Thus tapioca starch is prepared by placing a few drops of water on a half-dozen grains of tapioca and crushing them (not too severely) with the back of a spoon. If the starch is being treated with iodine, the iodized water can be used to moisten the coarse tapioca grains. Do not use too strong iodine, or the grains will be too densely colored.

One of the most valuable uses of the microscope around the home is the examination of fabrics. It reveals at a glance whether your shirt is wool, cotton, linen, silk, or rayon. Before it can do this, however, you must make yourself familiar with the appearance of these substances when magnified 100 or more diameters.

Wool cloth is made from the hair of some animal, usually the sheep. A hair has a definite structure and each animal produces a characteristic type. If you are familiar with the appearance of many hairs, you can identify the animal from which each comes. That is the method often used in criminal investigations.

But your suit or shirt is not a criminal, so you are concerned chiefly with the question of whether it is made of animal hairs or vegetable or animal fibers. Obtain a piece of wool—material you know is genuine wool and nothing else—and separate a few of the fine strands from one of the individual threads. Place these under your lenses. An undyed hair is preferable for study. The hair, when sharply focused and properly lighted, looks like a shingled rod. If you slice it in two, at an oblique angle so that it is virtually split lengthwise, you may be able to see the inner structure. There is a central core or medullary layer of rounded cells. Around this core or axis is the cortex, made of flattened, elongated cells. Outside are the overlapping, shinglelike plates or cells. It is the interlocking of these sharp-edged, projecting plates that makes the wool fibers adhere together to produce a cloth of great strength and wearing quality. Once you have made yourself familiar with wool, you cannot fail to identify it wherever you find it.

COTTON, likely to be found with wool in cloth that is not all wool, looks like a mass of twisted ribbons under the microscope. Each cotton strand is composed of cellulose covered with a thin skin. Along the center of the strand is a canal. If you can shift a cotton strand about until the end is seen in cross section, you will find that the form is like a crescent moon or an ellipse. Twisting of the cotton fibers is perhaps the most outstanding feature by which they can be identified at a glance.

The other important fabric material originating from a plant is flax from which linen is made. A flax strand at one time was a bast fiber in the plant, that is, a fiber that grew on the inner side of the bark. The flax fiber, like that of cotton, has a canal along its center, but the cells making up the fiber can be seen.

The two silks, real silk and rayon, are as unlike each other as day and night, when seen under the microscope. Artificial silk is made by squirting cellulose in solution through fine nozzles to form long, even strands that are combined into threads. A typical rayon fiber looks like a jointless rod. Its surface generally is marked with parallel lines, perhaps put there by the edges of the die through which it was passed. Rayon fibers are larger in size, in some cases, than genuine silk or other fabric materials.

PERHAPS you will be surprised to discover that real silk strands have a distinct structure. The silkworm, in spinning the glistening thread from which its cocoon was formed, used two sets of glands. The two spinnerets of one set each produced a single, fine strand of silk. As these strands emerged, they were brought together and cemented by a substance from the second set of glands. Perhaps the silkworm long ago learned the secret of the stranded cable and its greater strength when compared with a solid rod of equal size. Anyway, a strand of genuine silk looks like a rod or cord with a central canal or partition running through it. The surface of a silk strand may not be perfectly regular, but marked by occasional ragged projections.

After you have made yourself familiar with the important textile raw materials, and have analyzed all the cloth in sight, you can have a lot of fun examining papers and determining their origin. First of all, make yourself familiar with wood and straw fibers. Paper is composed chiefly of wood, straw, linen, and cotton fibers. Newspapers are made of wood; fine writing paper of linen or cloth.

To prepare paper for examination, tear it into small pieces and boil it in a weak solution of lye (caustic soda) until you have a pulp. This process frees the fibers from the filling and sizing materials. Wash the pulp well in clear water, and with the microscope examine a portion of it either in the wet or dry state.

You will see, on some of the fibers taken from the paper, rows of round or oval pits or pores. You may be able to make out distinctly the individual cells, and observe that some are long and others short. The fibers, for the most part, formerly were fibro-vascular bundles in living trees, and the pits or pores you see on them were involved in water circulation through the tree.

THE habit of examining everyday objects is one that may prove of real value to you. By detecting a fraud—perhaps by discovering that a suit for which you paid an all-wool price really is half cotton—you may save more than the cost of your microscope.

You can have a lot of fun identifying various kinds of furs, although you probably will run into difficulty in obtaining authentic standard specimens. The family cat, junior's pet rabbit, and the local zoo are possible sources of comparison specimens. Another important and interesting field is the examination of furniture woods. Usually you will have no trouble in removing a small sample from some obscure part of a chair, table, or cabinet. The microscope is the easiest and sometimes the only way of positively identifying a wood. (P. S. M., Dec. '33, p. 44.)

By employing *(Continued on page 105)*

BE A DETECTIVE WITH YOUR OWN MICROSCOPE

(Continued from page 104)

dark-field illumination, you can see things through your miscroscope that otherwise would be invisible or indistinct. To appreciate the advantage of the dark-field method, where the object itself seems to be emitting light against a black background, turn for a moment to astronomy. The stars are in the heavens in the daytime the same as at night, but you cannot see them because their feeble light is blotted out by the brilliant sky. At night the sky is black, the pupils of your eyes are dilated to admit more light, and the stars and the moon are clearly visible.

TO VIEW objects against a dark field, arrange the illumination so that no rays of light can pass into the microscope objective directly from the source of illumination. One way to accomplish this is to place the illuminator above the level of the microscope stage, so that its rays strike the object from one side. Another way is to place it below the stage, but to one side so that the rays pass obliquely through the object slide but do not strike the lens.

You can use the substage mirror to produce satisfactory dark-field effects. Often by simply tilting the mirror until the light beam barely grazes the object and misses the lens entirely, good results can be obtained. Swinging the mirror to one side, so that the beam is still more oblique in relation to the slide, is necessary in other cases, particularly when higher powers of magnification are used and the objective lens is closer to the slide.

Many objects which are not particularly attractive by transmitted light (bright-field illumination) become things of great beauty when seen against a dark field. They stand out with startling brilliancy because of the greater contrast with the background. Dark-field illumination, for instance, will enable you to see the cilia or tiny hairs covering the surface of animals from stagnant water.

In using the dark-field method, remember that the objects being inspected must be scattered over the slide so that light can reach them from the sides. Use a low magnification at first, until you get the illumination properly adjusted. Dark-field work, and for that matter the bright-field variety as well, is best done in a darkened room. Then stray light will not fall on the stage, and your eye pupils will be at their maximum openings. If the room cannot be darkened easily, a light shield made from cardboard and placed around the miscroscope or stage, will help. Arrangement of such a shield is illustrated.

Suitable objects for dark-field study at low or moderate powers, include the salt grains in butter, rotifers in pond or aquarium water, grains of tapioca starch and other starches, parts of insects, and a million and one other things.

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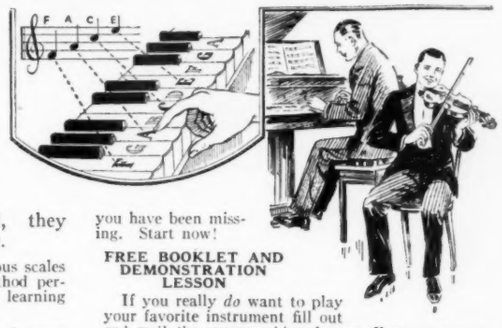
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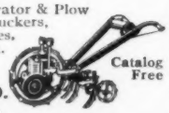

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STREET SIGN INVENTION PAID COLLEGE EXPENSES

WHEN Eugene Swold graduated from high school he lacked capital, was blessed with no influential friends or relatives, and had no omnipotent political pull. Like so many others, he ambitiously set about to find a job, hoping to earn money that he might enter a small college near his home the following Fall.

For weeks he haunted the employment offices of the local factories without success. Still hopeful, he visited relatives in the largest city near his home and answered want ads for nearly a month. Mostly they were ads that cleverly cloaked an unlucrative door-to-door selling proposition, or a project which required capital. Thoroughly discouraged he returned home.

A few days later he noticed for the first time something that he had seen every day for years. He saw that the small tin street markers attached to corner telephone posts were in a deplorable condition. Formulating an idea, he approached the Chamber of Commerce and city authorities, hoping to interest them in installing new ones. Both groups, faced with defaulting sources of income and curtailed budgets, were cold to his proposals.

BUT he had one more idea—an idea based on sound logical deduction. He reasoned that now, as never before, merchants facing decreased sales would rely on advertising to restore their normal turnover. So he decided to let merchants of the city pay for the erection of concrete posts which would serve the double purpose of being efficient advertisements and attractive markers.

He set about making a list of the more prominent street corners and solicited the outstanding merchants in the order of their importance, offering them their choice of these locations. The idea of a permanent advertisement for their business entailing but one outlay immediately appealed and the fact that they were helping to improve the appearance of the city carried some satisfaction also. Both points were stressed in selling these concessions. Advertisers paid enough to cover the cost of the posts and to provide a neat margin of profit for Eugene. Prices fluctuated with location, posts on the main thoroughfares which were well frequented com- *(Continued on page 107)*

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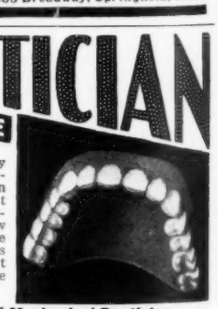

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MAKE MONEY TOO! Send check or Money Order $1.65 which includes Postage and Insurance. Sent C. O. D. if desired, 15c extra.

PRO TENNIS STRING CO., Dept. R-2, Harmon, N.Y.

Secrets of Success

STREET SIGN INVENTION PAID COLLEGE EXPENSES

(Continued from page 106)

manding about twice the figure asked for those installed on more obscure streets.

Permission to erect such posts on the boulevards was readily obtained from municipal authorities, since such work fell into the category of civic improvement. This granted, Swold set about making triangular shaped posts in a trough-shaped mold. The posts were about eight inches wide and three feet long, the length being ample for setting in holes. The upper side of the concrete in the molds was levelled off, and the name of the street and the corresponding subscriber lettered thereon.

Neighboring towns likewise were canvassed, and markers erected. Bird baths and custom built rock gardens were added to his repertoire as he gained proficiency.

The story ends as it should—in the fall of the year. Eugene Swold had enough money to enter college.—B. B., Ava, Illinois.

• • •

RUSTY STOVE PUT HIM BACK ON HIS FEET

AT ONE time Mr. Winn was a wealthy man, as reckoned by any standard. But as the last few years ran their course, mail after mail had brought him the discouraging news that he had been wiped out on bonds here and stocks there, and leases somewhere else, until he had only about enough capital left to start in a small business.

He listened with interest to the statement of a real estate dealer that "Blankville was the only city in the United States not hit by the depression." Not only did he listen to this statement but he permitted himself to be talked into buying a small business there. He soon discovered, however, that the above statement was only a high-powered selling tool, and knew that the sooner he got from under the load he was carrying, the better off he would be.

He had worked ceaselessly for months, for nothing, in the depressionless city. Then he sold or rather gave away the business and returned to his home with just about enough capital to keep the wolf on the run for a year. To one past sixty a year is very short indeed. He knew he must get busy at once.

One day as he drove along the street in his car which had been changed from a Buick to a Ford, he was attracted by a large crowd and *(Continued on page 108)*

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Employ managers, engineers, operators, installation and maintenance men for jobs paying up to $5,000 a year.

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1696 Boston Road **New York, N. Y.**

Secrets of Success

RUSTY STOVE PUT HIM BACK ON HIS FEET

(Continued from page 107)

the full, deep voice of a wiry little man, calling out, "One dollar, one dollar, do I hear on dollar-fifty? A dollar-fifty, do I hear a dollar-fifty?"

"A dollar-fifty," Mr. Winn said; another voice added five cents; Mr. Winn added another five and discovered he had bought a No. 16, Florence Heater, dirty, rusty and in need of a new bowl.

While he stood in the crowd waiting for the rest of the auction, he thought about the possible profits to be made from repairing, refinishing, and re-selling furniture of this kind. He decided to see what he could do with the stove. He paid fifty cents for delivery to his home, and although stove parts are very high, when he sold the stove a few weeks later for $10.00, he discovered he had made 100% profit. That gave him his idea.

He attended auctions regularly, buying everything needed in the home, garden and work-shop. Rounds, slats and seats, which seemed nothing more than kindling wood, he returned to their natural element —rocking chairs. He rebuilt and refinished tables, dressers and beds.

He and his wife did not really need all of their five room cottage, so they converted their large living room into a display room. Then he went to a sign painter and had a sign made which reads:

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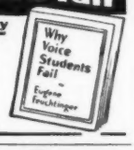

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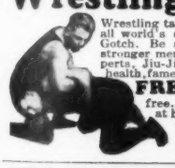

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HOME TESTS REVEAL NATURE OF SULPHUR

(Continued from page 57)

escaping into the room. In operation, the bottle of sodium hydroxide solution will be analogous to the scrubber bottle used to absorb chlorine gas (P. S. M., Oct. '33, p. 50).

The amateur magician who knows his sulphur can change a glass of wine into milk merely by adding what appears to be water. The wine, however, is a solution of potassium permanganate while the water is colorless hydrogen sulphide solution. The milk will be a white suspension of sulphur formed by the mixing of the two solutions.

A similar trick in which water, milk, port wine, and golden champagne are poured from the same bottle also makes use of a common compound of sulphur. First, prepare the liquid for the bottle. This consists of iron-sulphate solution, made by dissolving about a teaspoonful of the chemical in a pint of warm water, to which about six drops of sulphuric acid are added. To make the illusion complete, use a brown bottle or a pottery pitcher rather than a clear glass container.

Next, prepare the four wine glasses. It is in these that the trick lies. The first glass, which is to contain the water, requires no preparation. The liquid in the bottle is colorless and resembles water. In the second, however, which is to contain the milk, place a small amount of calcium chloride solution. In the third, which is to contain the port wine, place some potassium permanganate. And finally in the fourth, place a small amount of sodium bicarbonate and a few drops of water.

Before showing the trick be sure to display the seemingly empty glasses and the bottle, announcing as you proceed exactly what each glass will contain. As the liquid is poured, it will remain colorless as it fills the first glass, change to a milky liquid in the second, become a red liquid in the third, and a good imitation of champagne in the fourth.

If in making your first try, you find that the action is slow, add more of the iron sulphate and sulphuric acid to the liquid.

PRINT PAPER MADE OF OLD TELEPHONE BOOKS

SIMPLY by changing the type of ink used in printing telephone directories, telephone companies are saving thousands of dollars a month. The use of the new ink enables them to reprocess the paper and use it again. Hitherto, the chemically inert carbon pigment used in the ink made it difficult to bleach the paper for reuse. The new ink contains an organic iron compound which can be bleached easily. During the past two years, the phone books of the larger cities between New York and Omaha have been collected and sent to the plants where the paper is bleached, reduced to pulp, and made into new sheets. In some cases, as much as eighty percent of the pulp was found suitable for producing high grade white paper of sufficient quality for use in books.

NIGHT AIR RICH IN RADIOACTIVE MATTER

WHEN you breathe after dark, you take into your system a third more radioactive matter than when you breathe during the day. Scientists of the Carnegie Institution, of Washington, D. C., have just discovered that radon, a gaseous form of radium, and other radioactive materials are thirty percent more abundant during the hours of darkness. The so-called "respiration of the soil," pouring radioactive matter and particles of electricity into the air, is believed to account for the difference.

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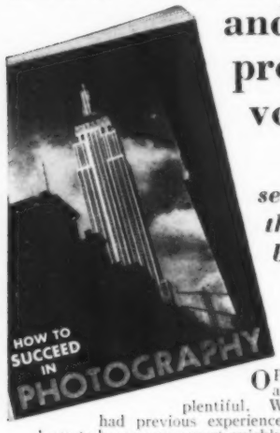

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P.S.M. 4-34

FASTER AND SAFER PLANES FROM WORLD'S BIGGEST WIND TUNNEL

(Continued from page 28)

many problems of flight can be solved by full-scale wind-tunnel research. But some of them have been thus solved, and in the two years of its existence the big N. A. C. A. tunnel has played an important part in the advancement of the science of aviation.

In other buildings of the Langley Memorial Laboratory, there are many other things as interesting as the gigantic wind tunnel. Instruments of uncanny ingenuity, machines that do model-making work of marvelous precision, electric-photographic apparatus that takes pictures of fuel sprays in engine cylinders with glass walls at the rate of 4,000 a second, and with a time exposure of one-millionth of a second!

MORE important than the instruments, and quite as interesting, are the results that the N. A. C. A. scientists have achieved with them.

Startling recent increases in the speed of commercial airplanes are the result of two major improvements in plane design. Among these important changes are:

The use of fillets where fuselage and wings, or nacelles and wings, join.

Efficient placing of engines in the wings of multi-engined planes, which is considered the most important single contribution to the progress of airplane efficiency since flying began.

Back of each of these improvements in airplane design lies much valuable research work by the N. A. C. A.

Five years ago it was suggested at the National Advisory Committee's annual engineering research conference with the aircraft industry at Langley Field, that a study of the effect of placing fillets between wings and fuselages be undertaken. Tests were made on a high-wing cabin monoplane with a stub wing, in the twenty-foot wind tunnel, with an air speed of 100 miles per hour. From them it was learned that when fillets of six-inch radius were used to fair the lower surface of the wing into the fuselage, the plane's drag of 300 pounds was reduced by two pounds, and that when twelve-inch fillets were used the drag was reduced by a little over five pounds. It also was determined that the use of the twelve-inch fillets increased the plane's propulsive efficiency by about one per cent.

THESE advantages seemed small, but the N. A. C. A. engineers knew that designers soon would be producing planes with lessened drag, and that then filleting would become increasingly important. So they continued their researches. Last year tests of a low-wing monoplane in the full scale tunnel showed that the use of fillets, in combination with the N. A. C. A. engine cowling, reduced the tail-buffeting oscillations to which this plane was subject to one-quarter of their original intensity, increased the ship's maximum lift eleven per cent, and decreased its minimum drag nine per cent.

Decreased drag means increased speed without increased power. Fillets, which prevent the premature breaking down of the air flow in the region of the intersection of the wing with the fuselage, now are used on all the super-fast planes. Experts say that this simple and inexpensive improvement has added twenty miles an hour to the speed of the newest airliners.

Most modern large airplanes have been powered by two, three, or even four engines. Three has been the usual number in recent years—one in the nose of the fuselage, and two in separate bodies, called nacelles, attached to the wings.

At the 1928 Engineering Research Conference at Langley Field several manufacturers requested the N. A. C. A. to conduct a series of tests on various nacelle positions.

The Advisory Committee's engineers started work on this problem in the twenty-foot propeller research tunnel. They built a wing with a fifteen-foot span, a five-foot chord—the chord of an airplane wing being the straight-line distance between its entering edge and its trailing edge—and a maximum thickness of twelve inches. They also built a four-ninths-scale model of a nacelle, in which they installed a detailed wooden model of a radial air-cooled engine.

Tests were made to determine the lift and drag of the wing alone. Other tests determined the drag of the nacelle alone. Then tests were made with the nacelle in twenty-one positions in reference to the wing.

Without the propeller, it was found that when the nacelle was located above and forward of the wing, the drag of the wing-nacelle combination was greater than the sum of the drags of wing and nacelle; while if the nacelle was located below and forward of the wing, the drag of the wing-nacelle combination was less than the sum of the drags of the wing and the nacelle.

WITH the propeller operating at full power, the wing's lift was increased when the nacelle was placed above the wing, decreased when below the wing, and unaffected when directly ahead of the wing.

The tests also showed that propulsive efficiency is highest when the propeller is placed directly forward of the wing.

Taking into consideration the factors of lift, drag, and populsive efficiency at both high speeds and cruising speeds, and in climbing and landing, it was found that the best all-around location for the nacelle is in line with the wing, with the propeller about twenty-five percent of the wing's chord ahead of the leading edge. The best results were achieved when the nacelle was efficiently cowled, and faired smoothly into the wing.

More than five years ago the N. A. C. A. made a pioneering investigation of the effects of cowling radial air-cooled engines. It proved that a large reduction of drag, resulting in a great increase of speed with the same power, could be obtained by the use of a cowling which completely enclosed the engine, the cooling air being admitted through an opening in the front and discharged through another opening in the rear of the engine. Further research resulted in the development of a N. A. C. A. cowling that in 1930 won the Collier Trophy. Since then many cowling researches have been made, and low-drag cowlings developed that have decreased engine drag by two-thirds and greatly increased speeds.

AN AIRLINER carrying a dozen passengers and a thousand pounds of cargo at a cruising speed of more than 200 miles an hour seems sensational to-day. But that speed will be commonplace in the near future. The N. A. C. A. engineers who have blazed the trail to the present high flying speeds have learned that size has little, and shape much, to do with resistance in the air—that a big plane has little more drag than a small one.

Looking forward, these scientists of flight place the ultimate speed limit at 600 miles per hour before the tremendous drag, caused by every added horsepower, will make further increase impossible. That speed would be possible only for straightaway flying, for no human tissue could stand the strain of changing direction at that breathtaking pace.

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HOW MOON AND SUN GENERATE THE TIDES

(Continued from page 51)

of the tides when it either reinforces or counteracts the moon's pull.

If the earth had no continents and was entirely covered by water, the two flood tides would follow the moon closely throughout the day, traveling at the rate of about 1,000 miles an hour.

BUT, as a matter of fact, the tidal wave is slowed up and modified in thousands of different ways by the obstructions placed in its path by the land masses.

If we attempt to follow any particular high tide from east to west around the world's oceans, its progress will be shown by a map something like that shown on the second page of this article. The lines represent the conformation of the high water at hourly intervals, starting in the Pacific.

If you count the hour lines in this diagram, you will be surprised to see that it requires forty-eight hours for the wave to travel around the world from Australia to Alaska. In the meantime the moon has traveled around the world more than twice (due to the earth's rotation) and its attraction has complicated the original impulse with a second and third influence. In this way the tides are constantly varied in intricate ways by the changing positions of sun and moon.

One phenomenon of the tide remains however fairly constant, and that is that high tide comes fifty minutes later each day.

If you have stayed at the sea shore for a few days, you have noticed the length of the interval between high and low water. If it is high tide at ten o'clock in the morning, it will be low tide a little after four in the afternoon, or approximately six hours later. Another high tide will occur soon after ten in the evening, and another low tide at about half-past four in the morning.

Accordingly, there are two high tides and two low tides in every twenty-four hours, or, more properly in nearly twenty-five hours. If it is high tide one morning at ten o'clock the next day it will be high tide at about evelen o'clock. In this way the times of high and low tide change through the whole twenty-four hours.

The reason for this daily delay of high and low tides is simple. The moon travels east through about thirteen degrees, or one-twenty-eighth of its monthly orbit around the earth, during twenty-four hours. This delays its apparent east to west transit across the earth's oceans by about fifty minutes in twenty-four hours. Since the tidal wave follows the moon's meridian passage by a fixed interval for every place on earth, the tides are also delayed each day.

AMONG the many interesting effects of the tides along sea coasts are the remarkable rushes of water called bores, which run up wide-mouthed, rather shallow rivers at high tide. These are often so violent that they are dangerous to river navigation. One of the most striking bores in the world occurs in the Chinese river on which Hankow is situated, but others occur in the Seine in France, the Severn in England, and the Ganges in India.

JUPITER'S ATTRACTION SPOILS METEOR SHOW

JUPITER is responsible for the fact that in recent years the shower of Leonid meteors is less brilliant than formerly, according to Prof. Wayne B. Hales, of the University of Utah. This planet, he declares, has drawn the meteors from their course, thus preventing their display from being seen on earth.

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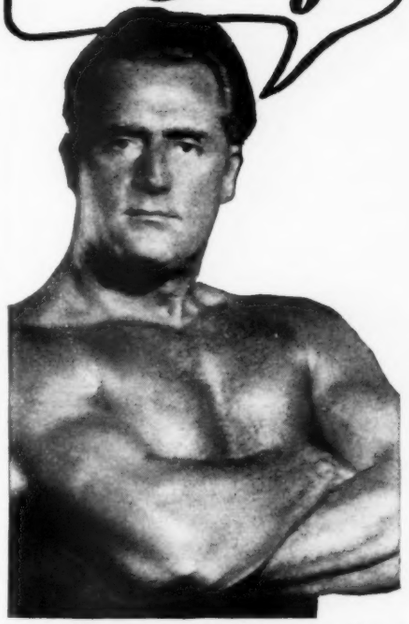

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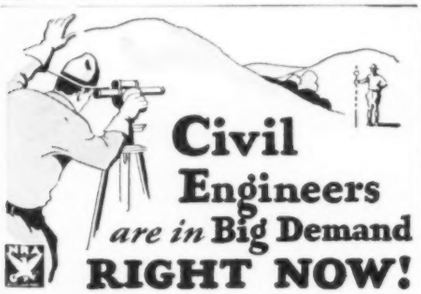

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LIVE ADVENTURES OF TAXIDERMISTS WITH THEIR DEAD ANIMALS

(Continued from page 35)

light, and durable, are now procurable ready-made, for the animals most commonly mounted, and are called manikins. They are adapted to the particular specimen with adhesive paste of several ingredients, and the skilful fingers and delicate tools of the taxidermist.

AKELEY and Clark also developed a new method of mounting hairless animals, especially elephants. The museum receives from the jungle head, hoofs, tusks, and a skin temporarily preserved where the kill was made and one and one-half inches thick. First it is carefully whittled down to three-eighths of an inch, that the external wrinkles may be more easily reproduced. Then the skin is bark tanned, a long process, perhaps a year if there are few skilled hands. Soft and durably flexible, it is stretched directly over the clay figure. Next, it is covered with plaster. Then the whole is cut in two, the clay dug out and replaced with a papier-mache manikin, strengthened inside with wooden ribs. Then the plaster is removed, the halves joined.

That is the method Clark employed in mounting the two big elephants added last year to the University of Nebraska's Adam Breede collection of big game animals. It is also the method being employed by some of the staff of fifty experts in creating the most imposing and fascinating collection in the American Museum's African Hall. Housed in the beautiful new Roosevelt Memorial addition to the Museum building in New York, this hall will show, lining its walls, upward of thirty separate habitat groups of notable African animals in lifelike poses, in natural surroundings, each against a background painted from actual observation. Clark made sketch models for many of them, while encamped amid their haunts. A complete model, a little gem, is usually made of every such group. The names of some of the groups tell the story. Lion Group, Waterhole Group, Nile River Group, Greater Kudu Group, Giant Eland Group.

This collection of the wonders of Africa, preserved to the life, surrounds the great central piece, the elephants, consisting of a herd of eight, of all ages. Some with trunks upraised, some quiescent, they portray every attitude of the monarch of Africa. The first four are in place already, mounted by Akeley, who conceived the idea before his death. The second four have just been received from Kenya, East Africa, where F. Trubee Davison, Director of the Museum, shot them, as they came thundering down to trample out the lives of his wife and himself.

Clark's newest contribution to taxidermy methods is also an elephant—but made entirely of paper. It is not papier-mache, the process is secret, but Clark's studio in the Bronx, New York, has developed a means to reproduce, seemingly to the life, a big, gray, wrinkled tusker even down to the tusks. They are paper, too. No museum need be ashamed of such a specimen, Clark thinks, and it can be obtained at smaller expense, and weighs less, than a real mounted skin and tusks.

THE studio is also proud of the biggest elephant it ever mounted—the head and fore-quarters of a beast one foot taller than the famous Jumbo, and bigger than Jumbo's recent successor, Khartoum. Each of the tusks weighed over 100 pounds, and was worth $1,000. The elephant was a trophy last year of Capt. Fred E. Lewis, of Spadra, Calif., who made many presents of suitcases, belts, and whatnot of the tanned hide from the hind quarters of the biggest of elephants.

Another well-known sportsman and polo-player brought home from Africa a zebra skin that Louis Jonas mounted on a fine, prancing hobby-horse, that bore the sportsman's young friends sturdily, thanks to half-inch steel rods inside the wood.

Strange things that come to taxidermists to be mounted include anteaters, alligators, skunks, rare sheep from Asia. A formidable task that once faced Fred Sauter, who continues the art of stuffing begun by his father in 1850, was that of mounting a 1,800 pound bull buffalo, the celebrated Black Diamond, long an attraction in the Central park zoo. First, however, he had to kill it.

THIS proved a much more heroic undertaking than Sauter anticipated. Blows from a butcher's sledge hammer and bullets from a police revolver merely bounded harmlessly from Black Diamond's solid skull. An attempt to kill him by hanging resulted only in the destruction of the hoisting apparatus. Finally a slaughter house attendant got close enough to the old buffalo to slit his throat with a razor-edged butcher's knife.

Sauter mounted the head, tanned the hide, and sold the meat to hotels. They all sent it back; Black Diamond was too tough.

There was recently completed at the Clark studio, a piece of work unique in taxidermy—the mounting of a giant ray weighing six tons. This strange sea monster, with its two-horned, winglike fins, got caught, off Brielle, N. J., in the anchor of A. L. Kahn's yacht. He took it ashore alive and put it on exhibition. It gave birth to a baby ray, which died, and is now in the Philadelphia Academy. Kahn got $3,000 in ten cent admission fees, and now hopes to make more money by exhibiting the mounted mother ray.

A somewhat similar job once came to Sauter. A man entered his place. With him, was a boy, pale and limping. The man asked;

"Can you fix up a shark so it'll look as if it was alive?"

Sauter said he could.

"I want you to do it for me," said his caller. "Did you read in the newspapers a while back, about a shark off the Jersey coast attacking a boy? Well, this is the boy, my son. The shark's jaws crippled him for life. He has had a long and expensive illness, and now I'm going to take him around the country lecturing about his experience. We want a shark, to take along and exhibit."

"You furnish the shark," said Sauter, "and I'll mount it for nothing."

He made it so lifelike, that at first, it gave the boy the jitters to look at it. But presently, father and son set forth with their stuffed shark, to seek their fortune.

FISH, of course, taxidermists have always with them. Else how would so many American dining rooms get those effigies of big trout? Small taxidermists thrive on fish, which they mount without extracting the oil, and deer-heads, which they stuff with sawdust.

In one studio, they had to cut a hole in the floor for the neck of a sixteen-foot giraffe, and men worked on the same animal on two floors at once.

Among the queerest animal specimens mounted in the American Museum, is a group called Solenodon paradoxus. It shows two animals, resembling a cross between an opossum and the *(Continued on page 113)*

LIVE ADVENTURES WITH DEAD ANIMALS

(Continued from page 112)

aardvark, beloved of cross-word puzzlers. Of one, the whole body is shown; of the other, only the head and long proboscis peep from a burrow.

The hunt for these specimens brought only a Solenodon and a half. The quaint animal, survival of a primitive type, was considered extinct, and a Russian museum had the single specimen in the world when Dr. G. Lagai and A. Hyatt Verrill got these. To do it took a brush with Santo Dominican revolutionists, much quinine, and months in the jungle whence Verrill returned gaunt, bearded, with one entire specimen and part of another. Also, he reported that this freak of nature roots like a hog, has claws, eats snakes, chickens, and bedbugs which it searches for in houses, comes out only at night, runs sideways, and when pursued, trips itself and tumbles head over heels. Then it sticks its head into a hole and is captured without a fight. The female, shown whole in the museum, gave birth soon after capture, to three naked young, and three days later died.

THOUSANDS of people take pets that have died to taxidermists for mounting. These include dogs, cats, birds, and monkeys. But there have been ocelots, garter-snakes, and the pet horse of a movie actress. Almost all ask that their former companions be preserved in some favorite pose of life, head on one side, ear cocked, or a wag put into a pet poodle's tail. Occasionally, they want the animal's body embalmed for burial.

There is real fun in doing jobs for the movies, as many taxidermists do. They started in the early days, when enthusiastic directors sometimes had stuffed Bengal tigers stalking the Maine woods. Soon they began consulting taxidermists. One assignment they gave Sauter, was producing 200 rats that would follow a Pied Piper of Hamelin. He got the rats from rat catchers, mounted them, and supplied each with an invisible wire to be hooked up with other wires. The day he delivered them at a Long Island studio, he turned some loose among the feminine extras—with satisfactory results.

How movie taxidermy has been perfected, is shown by the hippopotami that, in a current picture, realistically raise their heads above the surface of a river, then lower them. The heads were mounted and waterproofed at the Clark studio.

An odd job is making plaster casts to illustrate street railway accidents for lawsuits. The casts show the rail, cobblestones, and other surroundings so they can be explained to a jury. By-products of taxidermy are leather articles, screens, lampshades, elephant-foot umbrella stands, and other useful things.

PERHAPS the highest flight of modern taxidermy, is creating animals that never lived. An English sea captain asked Sauter to make him a mermaid. After some cogitation, he took the lower part of a large codfish, and the upper part of a lady monkey, mounted them, and sewed them together. Having provided the mermaid with an elegant tail, he crowned her head with long, wavy locks made from a horse's tail. To give her a beautiful face and other finishing touches, he called in Carl Rungeus, well-known animal painter. Then he put the finished product in a glass case, garnished with seashells. The captain was tickled to death.

"Wait till I show this to my landlubber friends!" he chuckled.

Sauter was tickled to death, too.

"Guess I'll make some more mermaids," he said.

He did, and sold them to side shows. Perhaps you have seen one.

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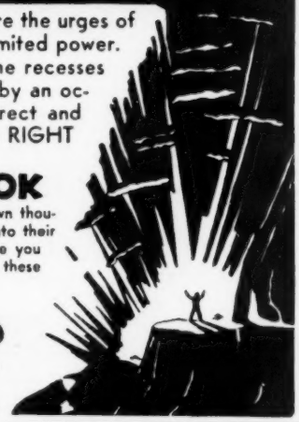

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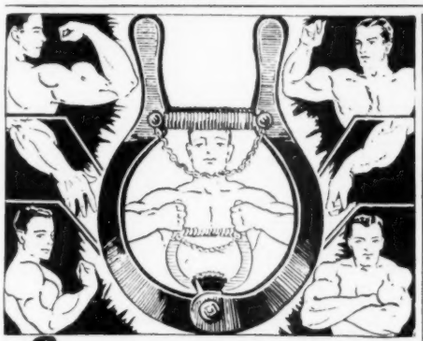

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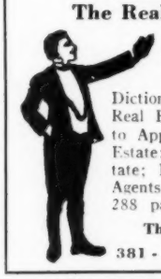

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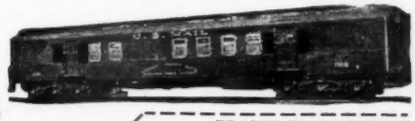

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SHORT-WAVE RECEIVER TO TAKE ON TRIPS

(Continued from page 63)

rear. This position was chosen to eliminate long power leads.

As shown in the photograph, most of the wiring is concealed under the chassis. Keep your leads as short as possible and follow the wiring diagram carefully, checking off each wire as the connection is made. Make the socket connections first and then follow with the others.

The cabinet for the receiver should measure approximately five and one-half inches deep, seven inches high, and ten and one-half inches long. It should, of course, be large enough inside to take the assembled chassis and tube shields.

On the front of the cabinet there should be four holes for the control shafts and a grill work for the speaker. Metal escutcheons, lettered from zero to one hundred, should be mounted under the tuning dials.

When the set is completed, connect it to a reasonably long antenna and insert the power plug in any 110-volt receptacle. Naturally, when a direct current supply is used, the plug must be inserted properly according to polarity; so, if the set fails to operate after several minutes, simply reverse the plug.

To tune the set, insert the proper coils for the band to be covered and manipulate the dials of the two tuning condensers. These should be turned together so their positions match. The regeneration is controlled with the resistance R_{10} and the small variable condenser C_3, the latter being particularly useful when tuning in C. W. (continuous-wave) stations. Remember that the dial-twisting type of tuning that brings in stations on your broadcast set will not work on the shorter waves. Tune the set carefully.

List of parts for this short-wave receiver follows. Letter and number refer to diagram on page 62.

C 1—140 mmf. variable condenser
C 2—140 mmf. variable condenser
C 3—50 mmf. variable condenser
C 4—.1 mmf. fixed condenser
C 5—.1 mmf. fixed condenser
C 6—.1 mmf. fixed condenser
C 7—20 mfd. midget by-pass condenser
C 8—20 mfd. midget by-pass condenser
C 9—1 mfd. fixed condenser
C10—8 mfd. dry electrolytic condenser } one
C11—8 mfd. dry electrolytic condenser } case
C12—12 mfd. dry electrolytic condenser } case
C13—.0001 mfd. fixed condenser
C14—.002 mfd. fixed condenser
C15—.01 mfd. fixed condenser
C16—.01 mfd. fixed condenser
R 1—350 ohm resistor
R 2—4 megohm resistor
R 3—300,000 ohm resistor
R 4—50,000 ohm resistor
R 5—300,000 ohm resistor
R 6—100,000 ohm resistor
R 7—2,000 ohm resistor
R 8—500 ohm resistor
R 9—25,000 ohm resistor
R10—20,000 ohm potentiometer
R11—2,000 ohm resistor
R12—153 ohm filament resistor (heavy duty)
A —Filter choke, 20 henry, 200 ohm
B —Field of dynamic speaker, 3,000 ohms
Ch —Short wave radio frequency choke
D —Set of five four-prong short wave coils on ribbed forms
E —Set of five six-prong coil forms.
F —Midget dynamic speaker, 3,000 ohm field
G —Toggle switch
H —Plug and cord

One four-prong socket, one five-prong socket, five six-prong sockets, one chassis, two tube shields and bases, small knobs and escutcheon plates, small cabinet (optional), connecting wire, solder, etc.

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HUNTING YOUR CAR'S CASTER AND CAMBER

(Continued from page 64)

wheel has camber, the distance at the top should be less than the bottom distance.

"Toe-in can be measured with a tape measure and a large pair of inside calipers made from a couple of lengths of lathing. You have to measure the distances between the inside edges of the tire or rim at the front and at the rear.

"IF THE car is an old model, two long laths, pointed at the ends and fastened together one on top of the other with four or five heavy rubber bands will do to space off the measurements. Of course, on new cars you'll have to add arms at the ends to get around the motor pan.

"As for caster, you can use an adjustable spirit level to check that. The caster angle generally is obtained by the twist of the axle. So by placing the spirit level crosswise on the axle, first at one end and then at the other, and adjusting it, you can measure each angle.

"Suppose some of these adjustments are wrong," interrupted Bill, "how do you make them right?"

"Well, if the caster, for example, is wrong, it generally means that the axle has been bent in an accident. Naturally the only way to fix it is to bend it back."

"Do you have to heat it?" asked Bill.

"That's the one thing you shouldn't do," declared Gus positively. "Heat would spoil the original heat treatment that's responsible for the strength. If you have to bend it, do it with the metal cold. It's a tough job, though, and I wouldn't advise trying it unless you have experience and the right tools. Of course, if the caster is out only a little, you can correct it by loosening the spring saddles and driving wedge-shaped shims in between the spring and the spring seat. That will tip the axle.

"Camber can be changed by bending the portion of the axle between the springs and the wheels. As for toe-in, that's the easiest to adjust. All you've got to do is lengthen or shorten the front axle tie rod."

As Gus talked, Bill was inspecting each of the front wheels on his car. "But what makes you think my trouble is unequal caster?" he inquired at last.

"I'm just like a doctor," chuckled Gus. "I diagnose from symptoms. You complain of hard steering to the left and a tendency to pull to the right if you don't keep your hands on the wheel. My diagnosis from these symptoms is that each wheel has a different caster angle. The car turns to the right; that means that the right-hand wheel has less caster than the left.

"It's the same with camber, only you have to look in a different place for the symptoms. If you have too much camber, the outer edges of your tires will wear faster than the rest of your tread."

"WHAT are we going to do about my car?" asked Bill impatiently. "There's no sense checking the caster, if I can't fix it."

"Well," drawled Gus, "I'd suggest that you check all three adjustments just for the practice. You can learn a heap about your car that way. Then, when you find out just how much the caster is out, perhaps we can fix it with wedges.

"And, by the way, before you do any checking be sure that the car is absolutely level and that the tires are properly pumped."

With that, Gus turned and ambled toward the house. As he reached the front steps, he glanced back and grinned. Bill was hard at work, and Gus knew that doing was the best way of learning, and besides—now he could get back to that morning paper.

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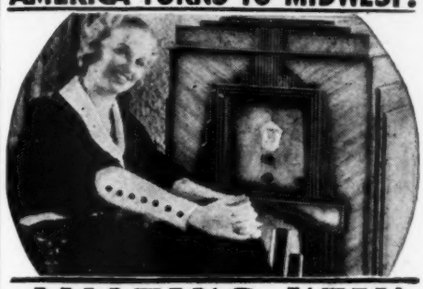

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NEW ENERGY TESTS SHOW OUR LOSS AT WORK AND PLAY

(Continued from page 31)

muscle is allowed to rest, the reverse takes place, 370 calories of heat disappearing as each gram of lactic acid is reconverted into glycogen. In experiments on a frog's muscle, using a thermometer capable of noting changes as small as a hundred thousandth of a degree Centigrade, Dr. Hill discovered that for every twitch of the muscle the temperature of the fibers rose about three one thousandths of a degree.

If you sprint 100 yards as fast as you can, your muscles will produce about an ounce of lactic acid. You feel tired in proportion to the amount of this acid in your system, for lactic acid and fatigue are synonymous. In the blood of tired athletes, Dr. Hill found thirty-five times as much of this fatigue chemical as he did in the veins of a rested man.

A CURIOUS fact in this connection is that we recover in our legs from exercise taken in our arms! That is, the muscles all over the body are busy turning lactic acid back into glycogen when one part of our body is exercised. If this were not so, your arm muscles would become tired out in using a hammer or your leg muscles in peddling a bicycle long before they do. Incidentally, the muscles of warm-blooded animals are capable of twice as much work per unit of mass as those of cold-blooded animals. A man's muscle, for instance, is from two to ten times as strong per unit of mass as a frog's.

Because sugar is quickest transformed into glycogen, athletes are now being given this concentrated form of energy before important contests. It is usually most effective when eaten from a half to three quarters of an hour before the muscles are called into action. This gives time for the chemical engines to transform it and store it up for use.

At Yale University, Dr. Yardell Henderson has found that exhausted runners at the end of a race have used up practically all the sugar in the blood. They often show the same symptoms as are produced by an overdose of Insulin, the sugar-reducing chemical injected into the blood in the treatment of diabetes. While sugar is not the only fuel of muscular energy, it is the quickest starting, the most easily transformed into glycogen. Other foods rich in muscle fuel are bread, beans, cornmeal, hominy, honey. Foods aiding the oxygen-carrying power of the blood by adding iron are eggs, spinach, figs, lean beef, oatmeal, and prunes.

In making use of this food-fuel, our muscles form one of the most efficient machines in the world. A modern steam engine is between fifteen and twenty percent efficient. That is, it returns productive mechanical energy equivalent to about fifteen or twenty calories for every hundred calories of fuel burned in its boiler. Gasoline engines have an efficiency of twenty to twenty-five percent while Diesel engines run as high as thirty-five percent. But the trained muscles of the athlete top them all, exceeding forty percent. Edison once estimated that the horse is only two percent efficient, requiring annually the product of five acres to keep it running.

A SPRINTER studied by Prof. Wallace O. Fenn, of the University of Rochester, N. Y., developed six horsepower during short sprints and another examined by Dr. Hill, in England, reached eight and a half horsepower in covering the hundred yard dash in record time. Most of this power is required to overcome internal resistance to the swinging of arms and legs. Stopping also consumes energy. One test showed a track athlete uses as much energy in stopping as he would in running an additional five yards at the very top of his speed.

Such high output of muscle power is confined to short bursts of effort however. The average laborer during an eight-hour day develops less than one tenth horsepower.

SOME years ago, a United States Army officer, Capt. Brock Putnam, laid claim to the world's golf endurance record with a mark of 252 holes played in a single day. Later, Dr. P. V. Karpovich made tests and found that a player walking over a fairly level 6,000-yard golf course uses up as much energy as he would in climbing to the top of the Empire State Building five times.

While the human muscle is a highly efficient producer of power, a 2,000-pound-capacity dynamometer recently showed that the muscle of an ape, weight for weight, is three or four times stronger. One female chimpanzee in an eastern zoo exerted a 1,260-pound pull using both hands and a male chimpanzee, pulling with one hand from an awkward position, registered 847 pounds. This proved to be more than four times the pull husky football linemen could exert.

Turning to the insect world, you find bewildering records of strength and speed.

One scientist used a stop watch to time a black carpenter ant climbing the side of a stump. Carrying a dead spider twice as big as itself, the insect mounted vertically two feet in less than two seconds. As it measured only a quarter of an inch in length, it was traveling more than forty-eight times its length a second. A 200-mile-an-hour racing automobile would cover only half as many times its length in the same time.

An even swifter insect is the spider which weaves funnel-shaped webs in meadows and weed-lots. In proportion to its size, it is probably the fastest thing on legs. In one instance, it was timed crossing a level table, covering more than a hundred times its length a second. The observer calculated that a locomotive traveling at proportional speed would go four times as fast as the speed of sound and would cross the country from New York to Los Angeles in about one hour!

THE strong men of the insect world are the beetles. Weight for weight, they are undoubtedly the strongest things alive. By piling tiny bags of fine shot, weighing from an eighth of an ounce up, on the backs of dung beetles, one experimenter made some amazing discoveries. A beetle which weighed only four and two-tenths grains was able to walk off with a load of eight and a fourth ounces piled on its back. This is more than 850 times its weight!

Another beetle, weighing six grains, lifted eleven and a half ounces. If a 150-pound man had proportional strength, he could pile twenty-five seven-passenger, two-and-a-half-ton limousines on top of each other and walk off with the load on his back!

However, in comparison with most living things, the muscles of man rank high as they are far more efficient than those of a majority of other animals. Recently, scientists have learned many things about how these chemical engines function and why they tire, but there are still a host of problems.

Why does brain work tire us? Why does a vegetable diet lower the amount of energy needed to run the body? How does a message from the brain convert glycogen into lactic acid? Why is the muscle of an ape more efficient than the muscle of a man?

In an effort to erase these and other question marks, scientists in various parts of the world are shaping new experiments.

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HOW NIGHTHAWK TRUCKS MOVE THE NATION'S GOODS

(Continued from page 19)

towers, and out into the open country. A cold mist is closing in. Telephone wires, white silos, and mailboxes with drooping flags are covered with moisture and have a silvery sheen in the beams of our headlights.

FROM our seats, high in the cab, the lights of approaching cars seem to pass under us. By eleven o'clock, we have traveled nearly forty miles over hilly country. At Runk's Road, Sleepy throttles down and eases over to the curb across from an electric sign: "WIN'S DINER." It is our first stop to "coffee up."

Inside, "Red," the waiter, is carving thick slices from a boiled ham and kidding with a row of truck drivers perched on stools at the counter. Over the coffee percolator is the cheerful greeting: "USE LESS SUGAR AND STIR LIKE THE DEVIL. WE DON'T MIND THE NOISE."

While we gulp down sandwiches and hot coffee, Sleepy gathers the news of the road from the other drivers, Curley, Butch, Skippy, Herb, and Foggy. There are reports of speedtraps, detours and "weighing in" to check on the legal limit of 17,000 pounds for trucks and 16,000 pounds for trailers. In Pennsylvania, the police carry jack scales in cars, watch trucks labor up steep grades, and picking out the overloaded machines weigh them in.

When we leave Win's Diner, the fog has thickened. Sleepy snaps out the dashlight to see better. A pale greenish glow enters the cab windows, coming from the high clearance lights running along the top of the truck, eleven feet, two inches above the ground. Thirty-Five, Sleepy explains, is a good fog machine. Its headlights are set low, illuminating the concrete. Asphalt, being black, is the worst kind of a highway for fog driving.

A long, gray bus flashes past and disappears in the mist. Suddenly, high in the sky ahead of us, we see two dim, close-set lights dropping steadily toward the ground as though in a descending balloon. They brighten and out of the mist comes a car which has just descended the invisible road down the long Gap hill, highest point on the highway.

On this forty-five percent incline, the truck loses headway rapidly. Sleepy shifts gears five times on the way up. Thirty-Five has eight speeds forward and two in reverse. "Now watch her lay back her ears and dig in!" he says as he shifts the last time. Slowly, the thundering engine drags the fifteen-ton load up the last hundred yards of the hill and over "the peak."

On the other side, the fog is even worse. It is billowing up the slope like rolls of cotton batting. Sleepy knows every inch of the road and plunges down the hill for the long toboggan to the bottom. He has figured out what to do in every possible emergency. If the brakes should fail on a long hill, he would run the truck to the side of the road and, if possible, slide it along an embankment until it stopped. In snow, if the machine started to slide backward downhill, he would cut the front wheels at right angles to the road, the added resistance stopping the slide before it could gain momentum.

ONCE, on Sleighmaker Hill, beyond the Gap, he lost his trailer. There was a jump, a jerk and the truck stopped in its tracks nearly throwing him through the windshield. An automatic mechanism sets the brakes of both truck and trailer when the air and electric connections break apart. Another time, Sleepy was struggling to get over the Gap when he noticed in his rear-view mirror a red patch coming and going on the wet pavement behind him. His brakes were on fire. The emergency lever had worked back a notch and the friction had started the fire. He leaped out and smothered the blaze with sand.

MIDNIGHT has struck before we sight the blue whirling search beam and the red boundary lights of the emergency landing field near Coatsville. Cars are thinning out on the roads. On the downgrade, we meet a slow truck climbing the hill with the headlights of three impatient passenger machines peering like eyes from around the rear. Then miles go by without a car in sight.

It is the hour of the trucks. We pass a big machine loaded with logs, another carrying seafood, a third packed with livestock. More than 12,000,000 head of livestock a year now go to market by motor truck.

Beyond Coatesville, we strike the long Malvern Hill, a lonely incline flanked by woods and ramshackle dwellings. A few years ago, one of the silk trucks of the York fleet was climbing this hill when a roadster containing three men tried to force it into the ditch. Failing, they pulled alongside and fired two shots pointblank into the bulletproof glass of the window, then sped away before the driver could stop and return their fire.

Not far from the Newark Airport, Sleepy encountered a gang of high-speed thieves on an open highway early last year. Twice, he reached New York with the tarpaulin over his truck slit from side to side and packages missing. Later, police nabbed the gang. They would drive their speedy machine alongside a truck on the right, or blind, side. One of their members would scramble aboard, slit the tarpaulin, toss off the packages and then transfer back to the car which would drop behind and pick up the loot.

By two A. M., we are running through small towns on the outskirts of Philadelphia. The fog is lifting. At Wayne, we pass Thirty-Six, the twin of our machine, going west with Herman Klausen at the wheel. The following night, when they meet again near the same spot, Thirty-Six will be going east, Thirty-Five heading west. Each driver makes three round trips a week.

Wayne, Sleepy says, has the most alert police along the line. They are always on their toes. They not only know all the trucks but how each driver handles his machine. A few months ago, this knowledge played an important part in capturing three stickup men preying on truckmen along the Lincoln Highway.

Ten miles west of the city, they hijacked a truck, left the driver tied up in a ditch and headed for Philadelphia. They made the mistake of going through Wayne. An alert traffic officer, watched the truck go by, noticed it was being handled in a manner different from usual, investigated, and nabbed the crooks red-handed!

BREAD trucks are starting their runs and milkmen with lanterns are taking to their routes, as we pull into Philadelphia. Because the traffic lights go off at one A. M., the truck fleet tries to strike this largest city along the route after that hour.

If you think it doesn't take any brains to drive a truck, ride with Sleepy Ulrich through a big city. It is almost uncanny the way he sets his *(Continued on page 119)*

HOW NIGHTHAWK TRUCKS MOVE NATION'S GOODS

(Continued from page 118)

pace, speeding up or slowing down blocks away, to hit the traffic lights just as they go green. He knows every one of the seventy-five lights between York and Manhattan and the length of time each stays on. Changing gears and starting up is far more difficult with a fifteen-ton load than with an open roadster. So truck drivers strive to maintain an even pace throughout a trip.

THE worst night in the week for the highway express is Sunday. Then the roads are full of "Sunday drivers," old people returning from church, farmers visiting relatives, motorists who do little driving during the week. They drive slowly and carefully, so slowly they delay traffic, increase the amount of passing on the road, and consequently the number of accidents. Saturday night the traffic is heavier, but there are more young people driving. They go fast and keep from under foot.

At a Philadelphia service station, we make a quick stop for gas. Seventy-five gallons is burned up by the big engine on its one-way trip. Sleepy is out examining the lights, testing the drive chains, kicking the tires. Each of these huge doughnuts of rubber weighs in the neighborhood of 300 pounds.

It is three-thirty when we cross the Delaware and cut to the curb in front of the Pine Tree Diner. Sleepy shifts license plates. We have crossed the line and are in New Jersey.

This four-lane highway is probably the most heavily traveled truck route in the country. It is the main artery into Manhattan from the south and west. As we plow steadily northward, we pass an increasing number of machines—gasoline trucks, bread trucks, meat trucks, produce trucks, flower trucks, white trailers filled with milk, red machines with waving flags and "HIGH EXPLOSIVES" painted on the sides. They are all heading for New York. Thanksgiving turkeys, Christmas toys, New Year's calendars, Easter flowers, Fourth of July firecrackers, all travel this ribbon of concrete to supply the needs of America's largest city.

Our machine is like one corpuscle in a vast system of circulation streaming along arteries of concrete to keep the city alive. As we rush north, other machines are racing west down the coast of New England, south along the Hudson, east from northern New Jersey and southern New York. In the morning people find milk on their doorsteps, meat at the butcher's, bread at the baker's, newspapers in place, all because a host of trucks have been busy during the night. It is no overstatement to say that modern civilization rides on trucks.

SLEEPY'S watch shows five forty-five when we dive into the open mouth of the Holland Tunnel. More than 2,000,000 trucks a year use this 9,000-foot tube under the Hudson.

At the other end, we emerge into bare, deserted streets, wind half a dozen blocks between dark warehouses and then back into the glare of the York terminal. Sleepy cuts the switch. It is a few minutes after six A. M. We have pulled a fifteen-ton load approximately 200 miles over hills, bridges, tunnels and highways in nine hours.

We climb stiffly from the cab. Sleepy delivers his tickets and then heads for his hotel room for eight hours sleep before the western run that night. Already crews of loaders are shifting our cargo to fast delivery trucks.

During the day, west-bound consignments will pour into the depot. Another twelve hours, and Thirty-Five will roll again—a link in a vast chain of modern, high-speed highway transportation.

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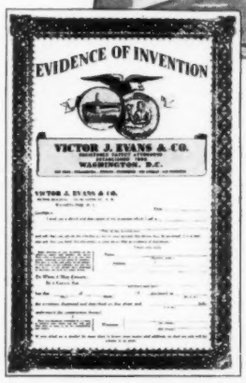

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New Mystery Rays Tap Atom's Power

(Continued from page 17)

detail in picture making. The hard ones are more penetrating and better adapted to the treatment of deep-seated disease.

One recent development has been the perfection of apparatus which enables the operator to shoot tremendous amounts of soft rays through the body, getting pictures that give detail with exposures so short that the skin is not burned. In 1896, it took twenty minutes to X-ray a bone; in 1928 the exposure had been reduced to one second; today it is accomplished in 1/120th of a second. Enough electric current is forced through the tube in that fraction of a second to light 3,000 ordinary thirty-watt bulbs. In such high-powered tubes, the machine-gun fire of the streaming cathode particles may drill a hole clear through the tungsten.

TO OVERCOME this difficulty, a Dutch inventor recently brought out a vacuum tube with a revolving target. An electromagnet travels around the outside of the glass of one neck of the tube. This keeps the metal disk within turning so the cathode particles hit in different places. Several of these tubes are in use in hospitals in the United States.

One has been employed by Dr. I. Seth Hirsch, of New York City, to collect three-and-a-half-foot radiographs of the human trunk. He has classified the stomachs according to their positions in the body. Some, he found are almost horizontal, others almost vertical, some at one angle, others at another. Such pictures, he suggests, may prove almost as good as fingerprints in identifying the owners.

To aid police in the work of identification, a Paris radiologist has just introduced an "X-ray fingerprint." He smears red lead lightly over the fingers before they are placed under the X-ray. The lead, collecting in the grooves between the ridges, outlines the whorls and markings of the fingerprints while the shape and size of the bones within the fingers give an added check upon the identity of the owner of the hand.

Not only men but minerals are now identified by means of the X-ray. It has been found that when a beam of the rays is sent through a pinhole in a block of lead and then through a tiny crystal of some mineral, an array of sharp spots forming a perfect pattern is recorded on a photographic film. Each mineral has its own pattern by which it can be recognized.

Using this method of examination, not long ago, workers at the Natural History Museum, in London, England, discovered an entirely new mineral. It was found among minute crystals brought from the Transvaal in South Africa. The name Bragite has been given it in honor of Sir William Bragg, whose researches on the structure of crystals won him the Nobel Prize.

How far a ray can penetrate a solid depends upon its wave length. The shorter the wave length, the more easily it can slip between the atoms. Light rays are 10,000 times as long as X-rays and X-rays are from ten to twenty times as long as the gamma rays of radium. Consequently, for the most penetrating work, the radiologist employs radium.

AT THE Watertown Arsenal, in Massachusetts, for instance, radium rays passed through twelve inches of solid steel and made perfect pictures through ten-inch castings. As a result, the U. S. Navy recently set aside $50,000 to purchase four "radium torches" for examining castings in navy yards on the Atlantic and Pacific. One of these tiny capsules revealed flaws that explained why stern post castings on five out of eight new cruisers had cracked under the strain of high speed maneuvers.

For X-rays, the limit of penetration is about four inches of steel. At Boulder Dam, a 300,000-volt, oil-immersed tube, with a lead-lined directing funnel like the horn of an old-fashioned phonograph, is peering through penstock pipes made of four-inch sheet steel. In examining the welded seams on the twenty-five miles of pipe, it will take 159,000 pictures and use up 24,000,000 square inches of film.

BOTH X-rays and gamma rays affect the sensitive emulsion of a photographic film in the same manner as light. The darkness of the film after it is developed depends upon the number of rays reaching it. Varying degrees of density in objects appear as varying shades of light and dark on the film. As birdshot would pepper the wood all around a steel object and thus leave its outline on a board, so the rays penetrate to the film all around a dense object, such as a key held in the hand, and reveal its size and shape.

At the recent American Congress of Radiology, held in Chicago, one of the ingenious devices on exhibit was an X-ray apparatus which enables you to see with your eyes shut! It is the invention of Dr. A. H. Pirie of the Royal Victoria Hospital in Montreal, Canada. The closed eye is placed against a sort of metal eyecup at the end of a tube. Within the tube are letters of lead which are reflected on the retina of the closed eye so they can be seen. By replacing the letters with a circle of lead which is divided into four parts, the operator can discover the exact location of bits of metal or other foreign objects buried in the eye.

Another application for the new device is testing the nerves of affected eyes. Not long ago, for instance, a man, blinded by cataracts, came to the hospital for an operation. He was first tested on the Pirie apparatus. It revealed that the nerves of the eyes under the cataracts were dead. Thus, an expensive and useless operation was avoided.

In X-ray and radium treatment, it is not the rays themselves that benefit; it is the trail of wreckage they leave behind in passing through the body. They collide with atoms, chip off electrons and send these electrified particles, released from their regular orbits, crashing back and forth like billiard balls, striking and injuring cells. The sick cancer cells are less able to withstand this battering by runaway electrons and are thus destroyed more easily than the normal, harder cells of the body. What actually happens to the destroyed cells, according to Dr. Raphael Isaacs of the University of Michigan, is that they are "speeded to old age" rather than being killed immediately. The electrons stimulate them, his researches have led him to conclude, until their life-cycle consumes but a small fraction of the time required for the normal cell to reach maturity, old age and death.

In this connection, sensational things have been accomplished recently by bathing plants with the invisible rays. At the Schenectady laboratory of the General Electric Company, for instance, a tiny grapefruit seedling, barely a month old, burst into flower after daily treatments with the X-ray. Ordinarily, these trees are five years old before their first flower appears.

MUCH remains to be learned about the effect of X-rays and gamma rays upon the human body. Special precautions are always taken to protect the workers in laboratories and hospitals. Sheets of lead, mats made of lead and rubber, glass containing lead salts and resin compounds impregnated with lead, are used to shield the experts from the rays. At the Mercy Hospital, in Chicago, twenty-two tons of lead line the treatment room where the 800-000-volt tube is used. The operator watches the patient through a device like a periscope and automatic switches cut off the current if any of the treatment room doors are accidentally left open.

The amount of radiation a patient can take depends upon his skin. The operator always stops before the skin is burned. Sometimes, when more of the rays are needed inside the body than the skin will stand, "cross-fire" technique is used. With the rest of the body protected by lead, the rays are sent through one spot. Then, with it protected, they are sent through another spot at a different angle. Thus, the total radiation received internally is greater than that received at any one point on the surface.

Probably the most unusual use of radium recently reported is an application made in Russia. Here it is snuffing out sparks and preventing fires in a rubber factory!

The air in the factory is saturated with explosive vapors. Sparks of static electricity generated in the drying machinery were a constant menace. Even fine wire brushes failed to carry off all the electricity. So tiny capsules of radium were placed near the machines where the sparks were most dangerous. The radium rays ionize the air, filling it with electrified particles which allow the static charges to flow to the nearest metal part and thence to the ground.

The whole amazing history of radiology covers a period of less than forty years. New discoveries, new equipment, new technique add to the possibilities for the future.

Most spectacular of these advances is the creation of the neutron ray by the California scientists. Its weird ability to pentrate hard objects more easily than the light ones is expected to make it an important new tool in a field of sensational research.

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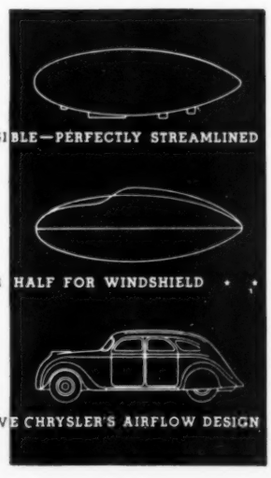

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